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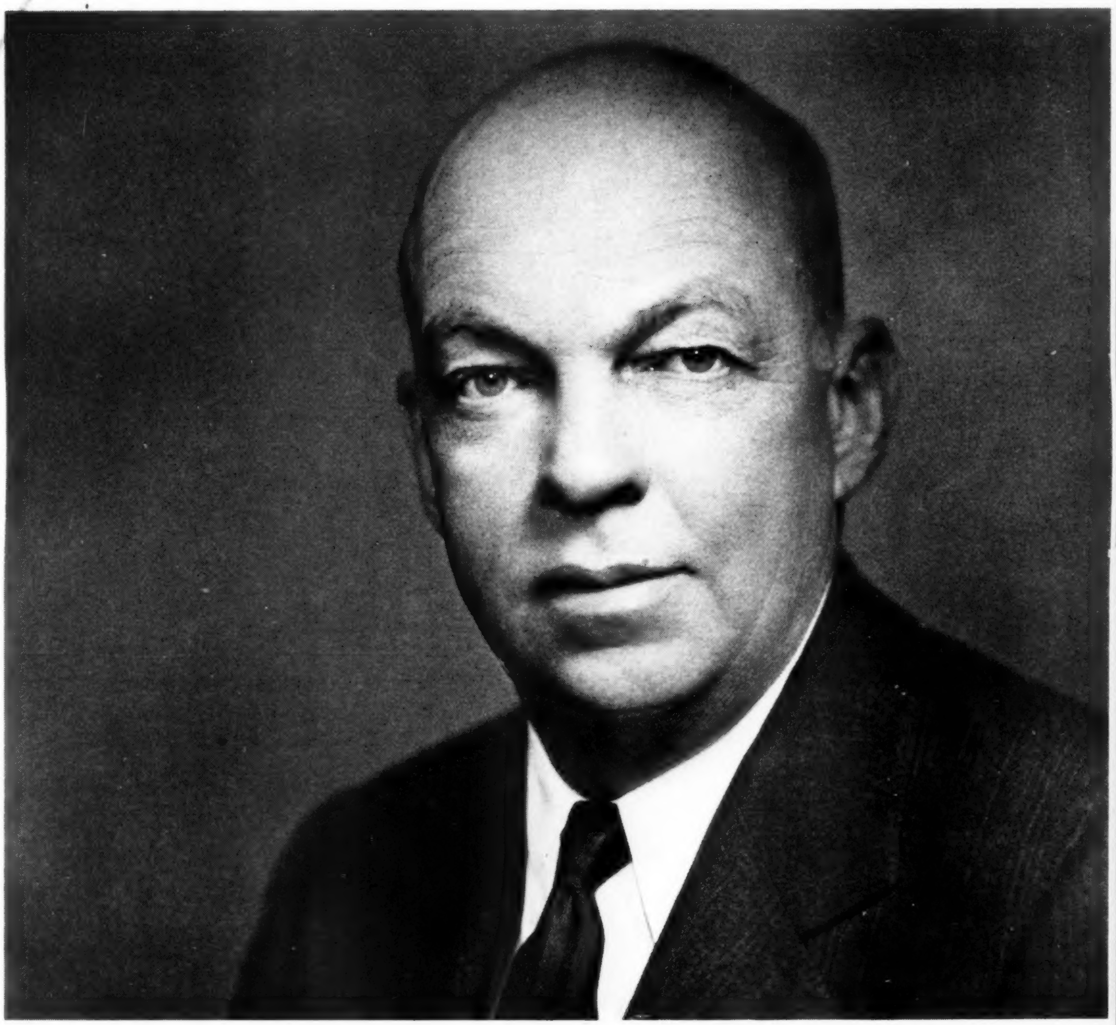

WESTERN SOCIETY OF ENGINEERS FOUNDED 1869

EDWIN HOWARD ARMSTRONG, 1951 WASHINGTON AWARD RECIPIENT

WSE MEETINGS—PAGE TWO

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Serving the Engineering Profession

March, 1951 CONTENTS Vol. 3, No. 7

COVER CREDIT

The 1951 Washington Award Address by Edwin Howard Armstrong appears on page 3 of this issue.

this month at WSE

COMING EVENTS OF INTEREST TO ALL MEMBERS

Thursday Noon Luncheon—Meetings

Every Thursday noon WSE members gather at headquarters for a double feature meeting. The bill of fare includes a man-sized meal, for $1.15, and a rapid fire speaker who holds his listeners' attention with a short, pertinent talk that ends in time to let members get back to the job by 1:30 p.m. Speakers at past luncheons have delved into such varied subjects as the making of arrowheads and the analysis of filtration problems. One of the talks on Propane buses in Chicago appears in this issue of the *Midwest Engineer.* Luncheon-meetings start promptly at 12:15 p.m. Make your reservation for next Thursday, now. Phone Ra 6-1736.

March 5, CBS Color Television

SPONSORED BY THE COMMUNICATIONS AND ELECTRICAL SECTIONS

Richard J. Mahler, industrial consultant to the Columbia Broadcasting System, will address the Western Society of Engineers on CBS Color Television. Since the recent decision by the FCC, adopting CBS color television as standard for the industry, CBS has received hundreds of requests from manufacturers and service organizations seeking information on color receivers, adapters, converters and two-point black-and-white television sets. Mr. Mahler handles all such requests, acting as liaison between CBS and all manufacturing and service organizations.

Mr. Mahler is a member of the Institute of Radio Engineers, the AIEE and the Society of Motion Picture and Television Engineers.

Plans to use the Commonwealth Edison assembly hall have been abandoned, and the meeting will be held, as usual, at WSE headquarters.

March 7, Junior Division Movie

Our American economic system will be the crux of an hour-long movie, "In Our Hands," when the Junior Division meets on Wednesday, March 7, at 7 p.m. The film, a joint production by the Inland Steel Co. and Borg Warner, released by the American Economic Foundation, is closely connected to the Junior's Profits Seminars which were recently completed.

March 12, 1st Toll Roads Talk

SPONSORED JOINTLY BY TRAFFIC ENGINEERING AND CITY PLANNING AND TRANSPORTATION SECTIONS

Toll Roads will be the subject of two general meetings this spring. One aspect of this complex and controversial problem will be discussed by **Mr. Walter Cleave,** on Monday, March 12. Mr. Cleave is manager of the Municipal Bond Department, the Blyth Co., Chicago bond and investment firm. He will talk on the financing of toll roads.

March 19, St. Pat's Party

St. Patrick was an engineer, and he insists on WSE engineers joining him in his annual celebration. WSE headquarters will turn into old Erin itself (with the help of the leprechauns), and everyone from County Cork to Killarney will be there. For dinner there'll be all you can eat of Corned Beef and Cabbage, for entertainment, the gay songs and laughter that typify Ireland. Be sure to make your reservations early, or you'll not be able to join St. Pat. Phone RA 6-1736. Price $3.75.

March 26, Mississippi Bridge Talk

SPONSORED BY BRIDGE AND STRUCTURAL SECTION AND ILLINOIS SECTION OF THE A.S.C.E.

The "Design and Construction of the East St. Louis Veterans' Memorial Bridge across the Mississippi" will be the subject of **Mr. A. L. R. Sanders'** talk before the general meeting, Monday, March 26, at 7 p.m. Mr. Sanders, WSE member, is Chief Engineer of Hazelet & Erdal, Consulting Engineers. His talk will be illustrated with colored slides. Mr. Sanders is chairman of the Illinois Chapter of The A.S.C.E.

A general discussion of the proposed constitutional amendment found on Page 22 of this issue will be held at this meeting.

March 31, Inland Steel Tour

A steel plant inspection to Inland Steel Co.'s Indiana Harbor Works is on the schedule for WSE excursioners. The tour of Inland's East Chicago, Indiana plant will begin promptly at 10 a.m., on Saturday, March 31.

Tourists may either take the Chicago South Shore train (orange cars) which leaves Randolph Street station at 9 a.m. or drive directly to the East Chicago plant. A chartered bus will meet those persons arriving at East Chicago by train. Those arriving in automobiles should drive to Inland Steel plant's Gate 2. All members will meet at Gate 2 where they will receive plant passes and will board buses that will take them on the tour. These excursion buses will charge 60¢ per person. Make your excursions early. Plans must be made to accommodate you. Phone Ra 6-1736.

April 2, Toll Road Engineering

SPONSORED JOINTLY BY THE TRANSPORTATION AND TRAFFIC AND CITY PLANNING SECTIONS

The second of two discussions on Toll Roads will be given by **Charles E. DeLeuw** (WSE), on April 2. Mr. DeLeuw, president of DeLeuw Cather, consulting engineers specializing in traffic and transportation problems, will speak on the "Engineering and Construction Aspects of Toll Roads."

Wrong Roads and Missed Chances—Some Ancient Radio History

A pioneer in communication, a professor at Columbia University and this year's Washington Award recipient, Edwin Howard Armstrong, chose as his address a study of the background of radio and the detours radio took before it became a world-wide reality.

By EDWIN HOWARD ARMSTRONG, 1951 Washington Award Recipient

The art of "signaling through space without wires" has passed the half-century mark. In that period, from the transmission of Morse signals over a mile or two of level ground, at speeds of a few words per minutes, it has progressed to the transmission of sound to the ends of the earth, and it has begun the same conquest of space for sight, by means of television. The industry that has been built upon the discoveries and inventions of the period has produced an effect upon our lives that, so far as I am aware, Nikola Tesla alone had the vision to prophesy.

But as the history of the art is written down, and its different phases are seen in the perspective that the passing of time alone makes possible, one is struck by the wrong roads that have been taken, and the chances that repeatedly have been missed to get back on the right ones.

It is difficult to find the facts about events of the early days of "wireless," for the pioneers are no longer with us; we cannot ask them why they did what they did do, and not something different. For later stages of radio development we are more fortunate; there are records from which we can reconstruct the history of the wrong roads that were taken, and of how the right roads were found. Perhaps the most illuminating chapter in this history is Marconi's discovery of the daylight wave—the discovery that created world-wide radio communication as we know it today. It is from that chapter of radio history that I shall try to draw the lesson of this paper. The story begins with Marconi's much earlier discovery of the grounded wave, which started wireless communication on its course.

Marconi, when he began his search in 1895 for a practical wireless signaling system, did not at first depart from the teachings of earlier experimenters, but proceeded along conventional lines and, by exercise of great ingenuity, extended the distance over which radio waves could be detected from a few hundred feet to a matter of several miles. His expressions of hope for longer distances met adverse criticism from scientists of the day, who recognized kinship between the waves from Marconi's beam and the light waves of a searchlight, and reasoned that the horizon must be the limit of a wireless signal, as of a searchlight's rays.

Had Marconi been more of a scientist and less of a discoverer, he might have concluded that his critics were right, and stopped where he was. But like all the discoverers who have pushed forward the frontiers of human knowledge, he refused to be bound by other men's reasoning. He went on with his experiments; and he discovered how, by attaching his transmitted waves to the surface of the earth, he could prevent them from traveling in straight lines, and make them slide over the horizon so effectively that in time they joined the continents of the world. Several years were to pass before agreement was reached on the nature of Marconi's great discovery, though Marconi himself understood very well how to apply it and to employ it usefully; and it proved to be the foundation upon which the practical art of wireless signaling was built.

Marconi's claim to the invention of wireless telegraphy is beyond challenge. Resurrection of the ancient claim of Professor A. S. Popoff, Marconi's Russian contemporary, fails because Popoff's suggested transmitter did not produce the grounded wave, and his proposal for a ground connection at the receiver, without one at the transmitter, proves that he lacked a conception of the basic principle that Marconi discovered.

For twenty years the "grounded waves," christened "Marconi waves" by my old teacher, Michael Pupin, were the accepted means of all long distance signaling. But today for long distance communication we no longer use them, save for a few special purposes. They have been replaced by a newer and radically different process of projecting waves into space, free of the earth, to bounce

(*Continued on Page* 4)

Reproduced above is a print made in 1901 at St. Johns, Newfoundland. Marconi and his associates are erecting a kite-supported antenna to receive the first trans-Atlantic radio signal sent from high-power station in England.

against an electrical ceiling 100 miles or so above the earth's surface, where they are reflected back to ground at some distant point. By a technique acquired through experience and based on the length of wave, the time of day and certain seasonal characteristics, we cause these waves to come back to earth in any desired area of reception.

Surprisingly enough it was Marconi who, more than 25 years after his original discovery, made the second great discovery that was to show that we had been on the wrong track, and to set us back on what we are presently pleased to consider the right one.

The story of how radio at the turn of the century went down what turned out to be a dead-end road, and how the right road was ultimately found, is a fascinating one. By 1900, Marconi had carried his experiments to a point where he was ready to make the great test of whether radio waves could be made to span the Atlantic. Accordingly, he built the first "high power" station in the world at Poldhu, England and went to St. Johns, Newfoundland to listen for the signal. There, in December, 1901, his bold project came to a successful conclusion when, with a kite-supported antenna, the agreed signal—the letter "S"—was occasionally detected.

We know all too little about the characteristics of the historic Poldhu transmitter, for the art of measuring wave lengths and antenna power was yet to be developed. The best present-day estimates place the wave length somewhat below 2,000 meters, and the power around 10 kilowatts. The experiment evidently showed Marconi that the gap between an occasional signal and regular transoceanic communication would be a large one, and that much more knowledge of the propagation of radio waves would have to be obtained.

In the following year, 1902, experiments conducted between the Poldhu transmitter and receiving equipment on the "S. S. Philadelphia" uncovered a new phenomenon—that Marconi's waves travelled better at night than by day. Various hypotheses, none of them satisfactory, were advanced to explain the loss of signal strength during the day, which came to be known as the "daylight effect." Marconi's reaction was characteristic; he began experimenting to extend the daylight range. His observations led him to try using longer waves; and after much experimenting, he satisfied himself that they gave him an improvement in daytime reception; and he also found it easier with the longer waves to generate high power. The more he experimented and observed, the more he was led in the direction of longer wave lengths. Other investigators in several countries arrived at the same conclusion, and without further thought, transoceanic communication went down the road of longer and longer wave lengths. Two decades later, the world was to be shown by Marconi that the road to world-wide communication lay in the opposite direction—the direction of short waves.

The goal of the pioneers was transoceanic communication, competitive financially with the solidly established cable systems. Toward that end the best technical brains of the art were directed, in the development of transmitters of higher and higher power and in the search for more sensitive detectors and more efficient antennas.

During the five or six years following the reception of transatlantic signals at St. Johns, Newfoundland, Marconi carried on ceaseless experiments, of which he has left an all too incomplete account. They culminated in the establishment during 1907 of the first transoceanic radio service, between stations at Glace Bay, Nova Scotia, and Clifden, Ireland. Spark transmitters of about 50 kilowatts power operating on wave lengths of several thousand meters were employed, with receivers using simple rectifying detectors, whose response depended entirely on the energy that could be abstracted from the incoming wave. Such a device as a vacuum tube amplifier was then a thing undreamed of. Continuity of service could be described as "somewhat uncertain."

Five more years of experience with the vagaries of the North Atlantic transmission path brought about a gradual lengthening of the waves of the two stations to approximately 5,000 and 6,000 meters respectively, with some improvement in the daytime service. During these dark ages of transoceanic communication, laborious development work was carried on by a number of organizations to produce a substitute for the imperfect spark system of transmission; and by 1913 several continuous wave generators, giving greater power than the spark system, were in operation. All efforts, as before, were centered on producing

(*Continued on Page* 5)

Wrong Roads and Missed Chances—Some Ancient Radio History

waves that were miles in length. The idea of shortening the waves for long distance service, instead of lengthening them, never occurred to anyone.

During this age of darkness, there was yet another instance of a light hidden under a bushel. In 1906 the 3-electrode vacuum tube—or "audion," as it was named—had been invented by Dr. Lee DeForest and put to use as a detector. Today the 3-electrode tube, in its manifold uses, is the key element in all radio transmission and reception. Yet for 6 years after it was invented it was merely another device, somewhat more sensitive than the crystals of the time, for changing radio impulses into currents within the audible range. It had no other use or purpose.

It has been a matter of wonderment that the audion, with its almost miraculous potentialities, was neglected by the art for 6 years, its mysteries unexplored. But in the perspective of today the reason is entirely clear. There was a theory of how it operated, which the art of the time generally accepted. Had the theory been right, the audion would have been a detector and nothing more. But the theory was wrong; and it remained for practical experimenters, in the face of what passed for knowledge at the time, to unravel the mysteries of the audion, disprove the theory and reveal the potentialities of what today is the primary tool of radio.

That was done in both the United States and Europe in 1912-13. The amplification of radio currents and the regenerative and oscillating circuits were discovered; and the sensitivity of radio receivers was increased a thousand-fold.

It would be pleasant to be able to record that communication improved in proportion, but that was not to be. The new method of reception made it possible for signals previously inaudible to be received as loudly as desired and it gave an improvement in radio communication, during certain parts of the day, that was beyond the wildest hopes of the inventors. But it also brought into focus a new problem, only less serious than the one that had been solved—the problem of atmospheric disturbances, or "static." So feeble were the signals that could be brought up to audible strength, and so great were the distances over which communication could now be carried on in the absence of static, that when static was present even on levels that previously would have passed unnoticed—it became the major factor limiting communication. It appeared, therefore, that still higher transmitter power would have to be generated to override the static, and that still longer wave lengths, with more expensive transmitter equipment, would have to be employed.

By the end of World War I, the radio communication companies had put a major part of their resources into the development of longwave, high-power transmitters of a variety of types—spark, quenched spark, timed spark, arc, the high frequency alternators of various countries (Alexanderson in the United States, Von Arco and Goldschmidt in Germany, and Latour in France) and the long wave vacuum tube generator. Waves 10,000 meters long were the order of the day. To radiate such waves, costly antenna structures had been erected, some almost 1,000 feet high and a mile long. Transoceanic communication had developed into a financial operation of frightening proportions.

It was an exasperating situation. The improved receiving means made it possible to operate perfectly, with relatively low power, during the undisturbed periods of the early morning hours. But with the coming of atmospheric disturbances in the afternoon and evening from electrical storms originating in the tropics, reception from even the highest powered transmitters was frequently blotted out. During such periods our best brute force method of more and more power (powers had reached the 500 kilowatt point) failed to match up to the forces of nature.

While we damned nature for its perversity in creating the static, we were happy about our ingenious transmitting and receiving equipment, which worked so well in the absence of disturbances. The idea that there might be a way of working with the forces of nature, rather than against them, seems to have been beyond the imagination of those working in the art. Another basic discovery was required to get off the dead-end road. Marconi was destined to make that discovery, but only after the chance to make it was repeatedly missed —by him and others—for nearly three years.

The ending of World War I released the experimental energies of a very able engineer of the British Marconi

(*Continued on Page* 21)

Marconi and operator at Glace Bay receiving station.

Armour Research...

Foundation of Future Technology

Want to know all about city noises? Where to find a rare chemical? How to get more oil out of the ground? What Mexico is doing research-wise for her national economy? Research men can tell you.

A chemical company once had a neglected by-product on its hands, "sodium fluosilicate". A research scientist showed that company how the chemical could save warehouses hundreds of millions of dollars each year in damage caused by rats.

Amateur sound movies have so far been stymied by high costs. The inventor of modern magnetic recording has built a laboratory model projector that adds sound at a price any hobbyist can afford.

The U. S. Air Force wanted to measure heat, a more difficult job than it sounds. They wanted to take their measurements at about 70 miles high. A team of engineers are assembling an instrument that looks like a cannonball; the metal sphere will pop out of a rocket whooshing upward at 1800 miles an hour.

These are just a few examples of the Herculean problems solved at Armour Research Foundation of Illinois Institute of Technology in Chicago where 650 scientists pool their talents on dozens of research projects. They're shaping the things the consumers will be buying next year and for many years to come. They're developing the processes, the instruments, the materials that engineers will be using to build a modern world. The Foundation's dozens of laboratories and offices occupy three and one-half acres of floor space in 11 different buildings. The staff handles about 300 projects, big and small, each year. They range from determining that housewives have been right all along in claiming that matches do mask unpleasant smells, to giving birth to a 40-million-dollar-a-year industry. Sponsors invest more than $4,000,000 annually there.

Growth and teamwork is the story of the Foundation. Dr. Haldon A. Leedy, Armour director, says, "We started out in the depression year of 1936 with three people, and we have been growing ever since. The success of the 'Armour Plan' is one reason for it, another has been industry's increasing interest in research."

The "Armour Plan" is a team plan. It is a method of pooling the brains, experience and talents of the Foundation's entire staff to solve a problem. A chemical engineer, a metallurgist, a ceramist, a physicist and an electrical engineer may all cooperate on one project. This is group research. This is scientific application of the old saying "Two heads are better than one." So far the Foundation has served more than 2,300 sponsors, and many companies have had

Left: Armour Research assistant adjusts gyroscope designed to stabilize cannonball-shaped directional thermometer which measures temperatures 70 miles high. The cannonball will be ejected from a rocket.

Armour Research . . . Foundation of Future Technology

programs at Armour for several years.

A non-profit organization, the Foundation began as an idea, the idea of research services to industry's order. Operating without endowment, the organization has supplemented its sponsors' research facilities and offered smaller companies an opportunity to hire trained people and expensive equipment for their own specific problems. Armour is a place where a company can farm out its research under contract, then own the results later.

"Scientific achievement is a dynamic not a static affair," Dr. Leedy contends. "We must run fast to stay where we are; to move ahead we must run still faster."

The Foundation operates at the tempo of industry. The lights in the labs burn late, and the staff members take bulging briefcases home at night. It's a young, enthusiastic staff, that eats, sleeps, talks research and spends intense hours over notebooks and reports. The staff members are outstanding graduates of technical schools around the world, men who have done industrial research for every type of company, and specialists in everything from carpentry to atom probing, from ceramics to tortilla testing.

Armour Plan in Action

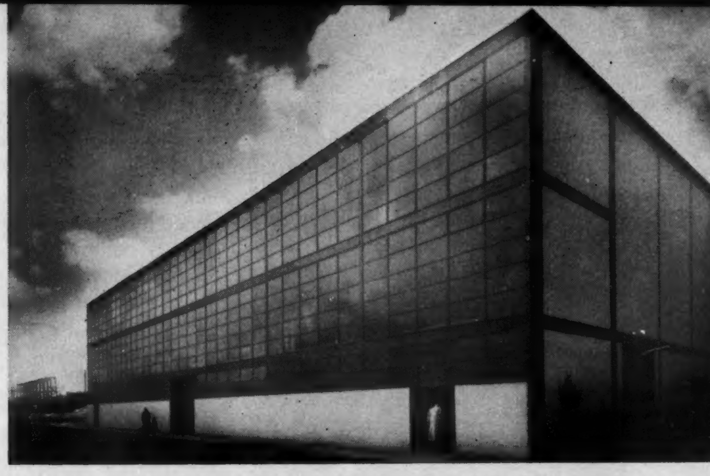
The life of a project at Armour Research Foundation, from the gleam in the eye of a research director to final report, runs a normal course. An industrial executive talks to Foundation people about a problem, and they agree on what the company wants. The Foundation estimates the cost of a specific research program for the prospective sponsor in a proposal. If the company accepts the proposal, a contract is signed.

Then the work begins. One man takes charge of the problem, but he is assisted by a team of experts in diverse fields who can contribute to the program.

A steering committee, made up of members of both the Foundation and the sponsoring company, meets regularly. Monthly reports, then a final report, go to the sponsor who retains any patent rights resulting from the project.

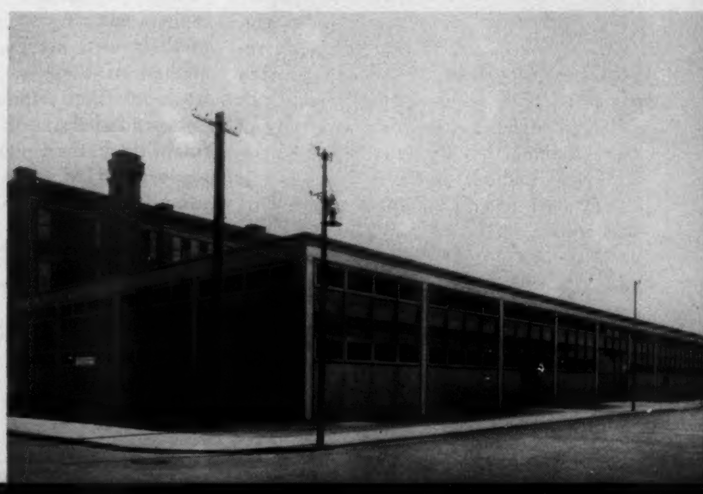
That's the pattern of operation. It varies with each project, of course, and the projects vary a great deal.

(*Continued on Page* 8)

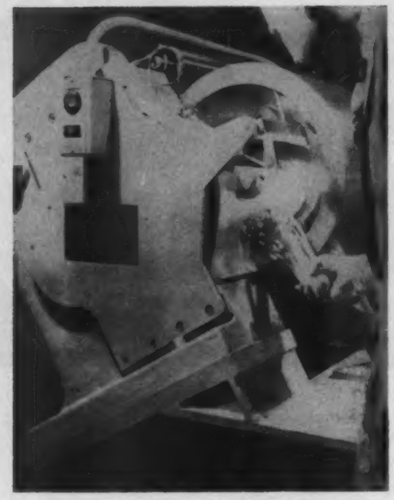


Above: Projects conducted in the Metals Research building range from the basic study of the element of silicon to the manufacturing problems of corrosion of silver-plated household lamps.

Above: Mexico City laboratory operated by Armour Research Foundation of Illinois Institute of Technology, and built by the Banco de Mexico in the interest of national development.



Right: Engineering Research building houses shops, offices, and laboratories for electrical engineering, ceramics and minerals, and applied mechanics.



Above: Chemical engineer "milks" celery to extract fluids from solids mechanically, in a present series of experiments.

Armour's three major divisions, Magnetic Recorder Division, International Division and Research have contributed greatly to the advancement of industry, and good foreign relations.

Armour Magnetic Recorder Division

Magnetic sound on film, an inexpensive method of putting sound track on 8 mm movies, is one outgrowth of the Foundation's revolutionary work in magnetic recording. The Foundation introduced the new magnetic recorder at the beginning of World War II, and the invention was widely used by the armed forces. Foundation discoveries in this field have opened undreamed-of possibilities in realistic reproduction of sound, facilitated the work of secretaries through improved magnetic recording dictation machines, provided and indispensable tool for radio stations, and opened a whole new field for amateur and professional movie photographers.

Last year over 300,000 magnetic recorders were sold by 54 companies licensed to use Foundation patents. In 1941, magnetic recording was on an experimental basis, relatively unsuccessful, and had almost been discarded in favor of disc and other types of recording.

Marvin Camras is largely responsible for the creation of this industry. A 34-year old physicist at the Foundation, he holds many patents in this field which are being used by companies in the United States and other countries.

Foundation licensees manufacture magnetic recorders for home entertainment, dictating machines for offices, high fidelity recorders used by radio broadcasters, movie cameras and projectors, and industrial control mechanisms.

The chief advantage of magnetic recording over other types, is that the recording can be erased and used over and over again. However, if a permanent recording is desired, the magnetic record will last for an unlimited period of time with no appreciable loss of fidelity.

The magnetic recorder has become a useful and interesting instrument for home entertainment and for such purposes as voice training and the recording of radio programs for future playbacks.

One of the outstanding developments of the Magnetic Recorder Division of Armour Research Foundation is Stereophonic Sound, or three dimensional sound. Scientists have tried, almost since sound was first recorded, to record on several sound tracks simultaneously and to play the sound back in synchronization, thus giving width, height, and depth similar to the original, natural sound.

As developed at the Foundation, the method is to record several sound tracks on a single width of tape. With microphones strategically placed throughout the area of the source of the sound, recordings can be made of the various portions of the total sound without concern for synchronization. On playback, the microphones are replaced by loudspeakers, in the same relative positions, enabling the recorded signal to be played back via several outlets, thus simulating live conditions.

Another useful development is the Foundation's work in magnetic sound on motion picture film. Amateur photographers may now make sound movies in their own homes, as a result of a method of bonding a magnetic sound track on film. After the manufacturer has processed the film and added the sound track, the amateur may add sound to 35 mm, 16 mm, and 8 mm sizes by using a magnetic sound projector.

In 1945 the Wire Recorder Development was established at the Foundation and it granted licenses to 19 manufacturers, including one in Canada and one in Great Britain.

The next year the Corporation was deactivated and the Magnetic Recorder Division took its place. Its work has increased since then, and the Foundation now has 41 domestic and 11 foreign licensees. Income derived from the licensing program is used for further basic research in all phases of magnetic recording.

Source Library of Chemicals

About 25 times a day every working day of the year someone makes an inquiry at the National Registry of Rare Chemical. Inquiries as to sources of rare chemicals come in by letter, phone, wire, transoceanic cable, or the inquirer may call in person at the Foundation. Armour's chemical detectives answer more than 8,000 requests a year. The number of inquiries has increased substantially each year of the Registry's seven-year history.

Registry files contain requests which run the gamut of research problems, from the ridiculous to the tragic, from requests by eccentrics with their panaceas for world ills to desperate, last-minute attempts to save human life. But the Foundation is most proud of the day-after-day help the Registry gives in catalyzing cooperation among the world's scientists.

Scope of operation of the Registry is indicated by inquiries from Argentina, Australia, Belgium, Canada, Chili, Cuba, Czechoslovakia, Denmark, England, Egypt, France, Germany, Hawaii, Holland, India, Mexico, Norway, Spain, Sweden, Switzerland, the Union of South Africa, and from every state in the United States.

The Registry, founded in 1942, is not a storehouse of chemicals. It is a large card file of sources of rare chemicals, and its services are free to any scientists needing them.

The Registry now lists sources of more than 18,000 rare compounds. About 75% of the 8,000 annual requests can be filled directly from the Registry's files. Other requests are filled from leads by scientists working with the same or similar compounds, and still other information is obtained as a result of notices published throughout the year with the cooperation of scientific journals.

The amount of time the Registry has saved the world's scientists would be

impossible to estimate. Frequently less than a gram of a certain chemical may be needed, but its preparation might require weeks of work. The large file of letters and communications the Registry has received is ample evidence that many an important project would have been seriously delayed, had the Registry not had on file sources of vital rare materials.

Foundation Runs International Division

The Foundation's International Division, with headquarters in Mexico City, specializes in research for other countries. A wax product worth $20,000,000 in annual exports and the first stable, dry tortilla flour acceptable to the Mexican public are among its successful projects.

Armour pioneered in the successful export of technical assistance for the economic development of other countries. Since 1942 its International Division has provided for other nations the same impartial, non-profit, non-political industrial research available in the United States. The Division is the only one of its type actually operating offices and laboratories outside the United States.

In 1942 the Foundation made a technological and economic survey of Argentina. Two years later the Armour Plan for International Technical Assistance was extended to Mexico with a nation-wide technological audit, under the sponsorship of the Banco de Mexico, S. A., organized and conducted jointly by U. S. and Mexican technologists. It has served in specific problems in Haiti and Puerto Rico, and has begun work for the development of El Salvador.

In 1949 the Economic Commission for Latin America of the United Nations selected the Foundation to report on the technological problems of Latin America and the means available for their solution.

Surveys for possible industrial development have been made in the fields of solid fuels, forest products, hides and leather, and hard fibers. Surveys and recommendations have been made for increased technical training and investigation in Mexico. The Foundation also sponsored a joint Mexican-U. S. conference on mutual technical problems.

In addition to advice on technical training, the International Division has conducted joint research with Mexican engineers and scientists. The Foundation has arranged for fellowships in the Foundation laboratories in Chicago and Mexico.

A new and complete laboratory for the practical solution of industrial problems in Mexico went into operation recently with the cooperation of the Banco de Mexico. Other laboratories, including the National Laboratory for Industrial Development, have received aid. Armour assisted in operation of a laboratory in Yucatan for the investigation of henequen fiber.

An economical process has been developed to industrialize cascalote tannin. This product, highly important to the Mexican leather industry, has been handled in a crude form in the past. Recent experiments indicate it may also serve as a substitute for quebracho in controlling the viscosity of mud in oil-well drilling.

During the war a process was developed for extracting quinine and other antimalaria drugs from the cinchona tree of Chiapas to allow Mexico to produce independent supplies of these materials.

Saving Mexican forests, industrializing vegetable oils, studying the manufacture of glass, matches and salt, are all part of the work of the Foundation's International Division.

Armour's Research Division

Third one of the Foundation's major divisions is the Research Division, consisting of six departments, each organized into sections. Each of the six research departments, Physics, Metals, Chemistry and Chemical Engineering, Applied Mechanics, Electrical Engineering, and Ceramics and Materials, is headed by a chairman, with a supervisor in charge of each section of the department.

Here is a sample of the variety of projects that go on in the Research Division.

The upper air will get its temperature taken by a metal sphere ejected from a rocket. The cannonball, which is 18 inches in diameter and filled with instruments for measuring heat from all directions, is in the final assembly stage.

Other research covers a broad field, from railroad cars to phonograph needles. For an oil producers association, chemists are looking for an inexpensive surface agent that will help obtain more oil from existing wells.

Infinitely small amounts of certain minerals are now considered essential to the soil if people are to eat nourishing food. These "trace elements," sometimes as little as one part in ten million, are the subject of Foundation study. Armour engineers are searching for a material to spread over ice-coated rivers and lakes to melt it earlier in the spring and give us a longer navigation season.

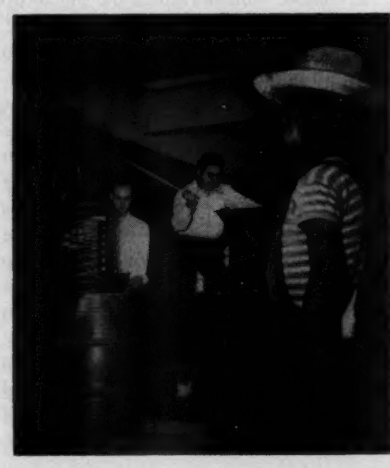
Electrical engineers built a mobile laboratory containing a ton and one-half of electronic instruments to measure what happens in big guns when they are fired. Physicists with sound level meters have been touring the streets of Chicago for months, on the trail of big city noises. Results of their exhaustive survey will be available to all cities who need to know more about noise and its causes before they write anti-noise ordinances.

In one of the Foundation's laboratories where precision electrical measurements are made is a clock which stays accurate to the second over a 55-day period. An engine laboratory runs day and night. Analytical chemists with delicate balances can weigh pencil marks, and physicists can blow up a dime to mile-size on an electron microscope.

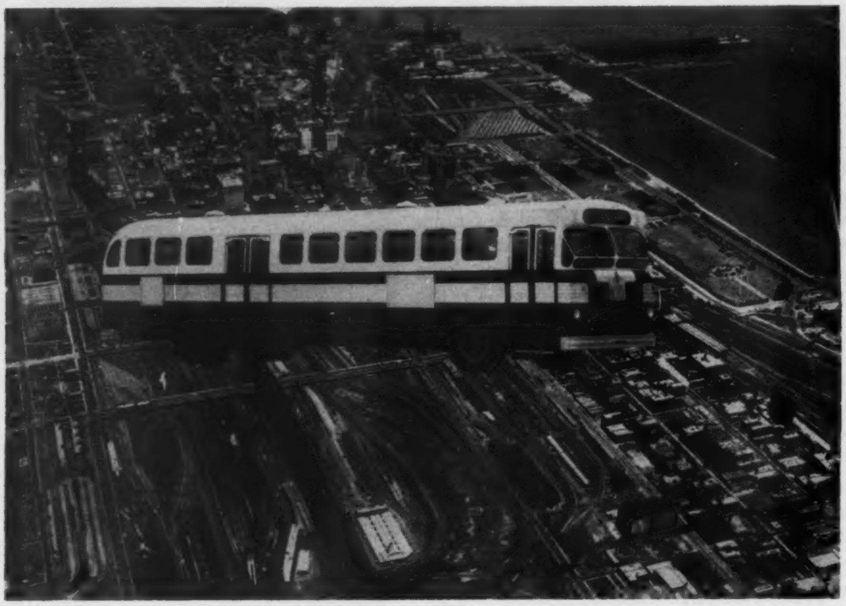
Sodium fluosilicate, a by-product of the phosphate industry, has a great production potential. Foundation researchers showed it to be a rat repellent, suitable for use on paperboard cartons.

(Continued on Page 29)

Below: Mexican boy watches International Division researchers test new tortilla flour which has aided Mexico's economy.



Propane Buses Invade Chicago



Given Before
WSE Luncheon-Meeting
October 19, 1950
by
S. D. FORSYTHE
Chief Engineer
Chicago Transit Authority

Before the Chicago Transit Authority invested eight and a half million dollars in propane propelled buses there was, as you may well realize, a great deal of quiet, thorough investigation of every phase of propane use and handling that could be given consideration. These investigations and explorations can be classified roughly into three groups:

1. Those considerations having to do with safety
2. Those considerations having to do with economy
3. Those considerations having to do with public acceptance

Unless we could convince ourselves that our public safety record would be as good or better with propane than with other motor fuels, we felt that we had no right to give propane serious consideration. Unless we felt that there was a substantial economic advantage to be obtained we felt that there was no compelling reason to go to its use on any more than an experimental basis. Unless we had a vehicle that would have enthusiastic public acceptance we had serious questions as to the wisdom of such a procedure.

On each of these points we were able to satisfy ourselves that there was a decided plus value to be obtained. Accordingly an order was given to the Twin Coach Company of Kent, Ohio, for 500, 51 seat buses, weighing 17,000 pounds empty and costing approximately $17,250.00 each. Let me tell you of the principal factors that contributed to each of these three considerations.

Safety, First Consideration

It is only right that safety be considered first. Propane is one of the family of liquefied petroleum gasses and it has been used extensively as a motor fuel on the continent of Europe and in the western and southwestern parts of this country for many years. It boils at —44 degrees Fahrenheit. The explosive or flammable range in a mixture of air for propane is between 2.4% and 9.5%. For gasoline the same range is between 1.3% and 6%. The specific gravity of propane is about 1.5 which is lighter than gasoline vapor which has a specific gravity of 2. Because of its low boiling point it must be handled, of course, in a closed system and under ordinary temperatures it will develop in the neighborhood of 150 pounds per square inch. An odorant, ethyl mercaptan, is added to the liquids and is of such a penetrating nature that leaks will be detected by the ordinary person long before there is sufficient accumulation of gas to develop an explosive mixture. The pressure system is designed for working pressures up to 250 lbs. (the customary setting of the relief valve) and for rupture values of 1000 lbs. per square inch. This means that the fuel tank is made of essentially ¼" boiler plate as contrasted with the sheet metal used in the ordinary gas tank and its rupture resistant value is therefore about 20 times greater.

The nightly fueling of buses presents one of the major fire hazards. Due in large measure to recent improvements in propane fueling tanks and dispensing nozzles perfected by engineering consultants to the petroleum industry located on the west coast, we expect the fueling of these buses to be a very trouble-free operation. In fact we feel that this has been one of the major contributions to the use of propane in intra-

(Continued on Page 28)

Open letter to me brother engineers:

Shure'n it'll be a gay time you'll be having at ***ST. PAT'S PARTY, MARCH 19TH.***

It's the truth I'm saying now, what with the fine dinner (CORNED BEEF AND CABBAGE, all you can eat) and the grand fun (a knighting ceremony will be just a bit o' the lark), you won't be home till you've caught yourself a leprechaun.

Be after making your reservations early, and be sure to bring the colleen along. The price is $3.75, it is.

I'll be seeing you there, and none of your blarney now.

St. Pat,

a fellow engineer

production economics in HYDRO-POWER

Part One of a Paper Presented before WSE on December 4, 1950

by

C. K. WILLEY

Hydraulic Engineer,

Harza Engineering Company

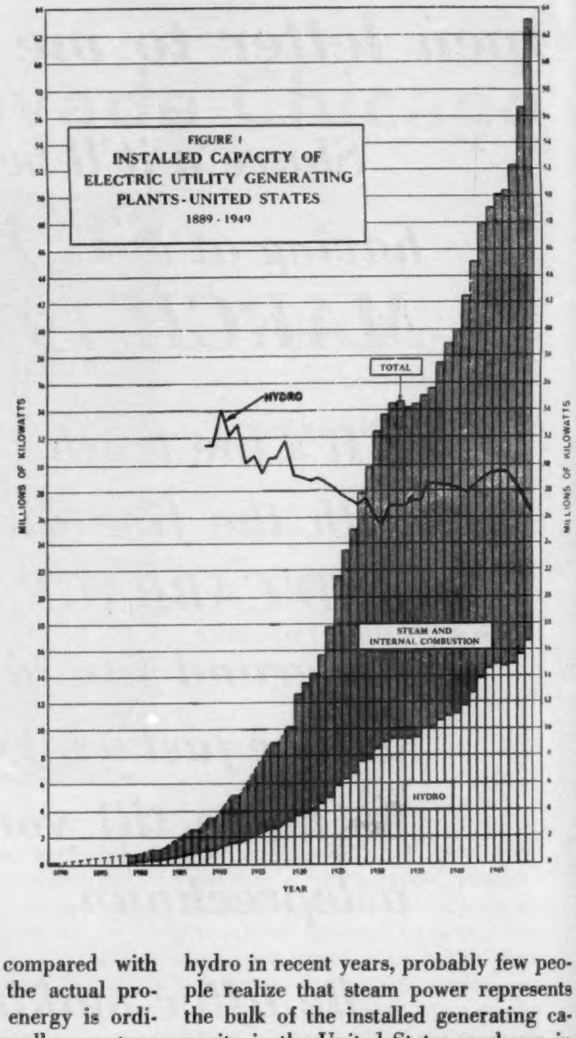


FIGURE 1
INSTALLED CAPACITY OF ELECTRIC UTILITY GENERATING PLANTS - UNITED STATES
1889 - 1949

In recent years the development of hydro-electric power has attracted the public fancy. By and large, this has been the result of publicity given the construction of great multiple purpose hydraulic projects by the federal government, such as Hoover and Grand Coulee Dams and the Tennessee Valley Authority projects. In addition, much of this publicity has served to awaken many of the more backward countries of the world to the resources of their rivers.

It is not the purpose of this paper to discuss the pros and cons of such a controversial subject as the generation and distribution of electric energy as a function of the federal government. However, it is unfortunate that the largely political use of the term, "cheap hydro-electric power" has created so much confusion and prejudiced opinions in the minds of laymen and engineers as well. There exists a great need to dispel the frequently encountered but erroneous impression that the cost of water power is insignificant when compared with steam power. Further, the actual production cost of electric energy is ordinarily only a relatively small percentage of the power bill for the average domestic consumer. Nor does the domestic consumer stop to realize that his power bill is about the only one which has actually continued to decline while the price of everything else has increased two-fold or more. In the U. S. the average cost per kilowatt hour has decreased from about 2½c in 1930, to 2c in 1940, and 1.6c in 1949. It is expected that greater use per customer will, in the future, maintain or even lower this average unit cost.

However, this paper is confined to energy production and does not elaborate on distribution and other costs which are common to all energy regardless of its source.

Hydro's Growth of Capacity

With all the publicity given federal hydro in recent years, probably few people realize that steam power represents the bulk of the installed generating capacity in the United States as shown in Figure 1. This chart includes only that capacity operated by public utilities, both publicly and privately owned. In addition, private industries operate about 13½ million kilowatts of generating capacity of which only 1 million kilowatts are hydro. Total generating capacity in the United States now totals 76½ million kilowatts; only 23% of 17½ million kilowatts is hydro. Since only about 3% of this total comprises internal combustion generation, three-fourths of the generating capacity in the United States is steam.

Figure 1 shows the growth of public utility generating capacity since the beginning of the industry. The periods of most rapid growth were the decades of the 20's and 40's. Growth in the 30's affected by the great depression of that era, was less than half that of the other

two decades. The installed capacity, though, has doubled in the past twenty years. Growth since the end of World War II has been phenomenal. During the past three years more capacity has been brought on the line than existed in the entire country in 1920. The *Electrical World* estimates that the total capacity will increase to 200 million kilowatts by 1965, or three times what it is today. Presumably this assumes so-called normal conditions, with the assumption for the moment that war is not a normal condition.

For the past 30 years, the relative balance between hydro and fuel burning plants has evidenced a fairly constant percentage. This percentage has varied between about 26% and 30% with the overall average 28%. While the hydro percentage dropped slightly in the past two years, this cannot be considered significant. Likely it results from postwar steam plant construction being completed in less time than hydro.

Relative Use Factors

Annual plant factor is the ratio of the energy actually produced to energy which might have been produced if operated at full capacity throughout the year. Figure 2 shows the average plant factors for the industry over the past thirty years and for both hydro and fuel plants. Practice in recent years of good demand indicates plant factors of about 60% for hydro and 50% for steam. The greater multiplicity of plants, increased system interconnections, and greater integration of steam with hydro have served to increase plant factors with attendant overall economy through the years. Hydro, since its total annual energy cost is little affected by the amount of time operated, is consistently higher than steam where fuel costs play an important part in energy cost.

It is significant to note that during the depression years when demands were down hydro was operated at nearly twice the annual plant factor of fuel plants. This, of course, resulted in considerable fuel economy to utilities with a substantial amount of hydro capacity.

The plant factor is not synonymous with the load factor. The two terms are sometimes used interchangeably, but this is erroneous. Load factor is the ratio of average load to peak load during the selected time period, daily, weekly, or annually.

Since hydro operates on a higher annual plant factor than steam, it follows that the percentage of energy generated by hydro when compared with steam is greater than its percentage of total capacity. During 1949, hydro produced 90 billion kilowatt hours of energy out of a total of 291 billion. Again, these figures are for public utility plants only. This represents about 31% of the total energy from 27% of the total capacity.

Development of Hydro Capacity

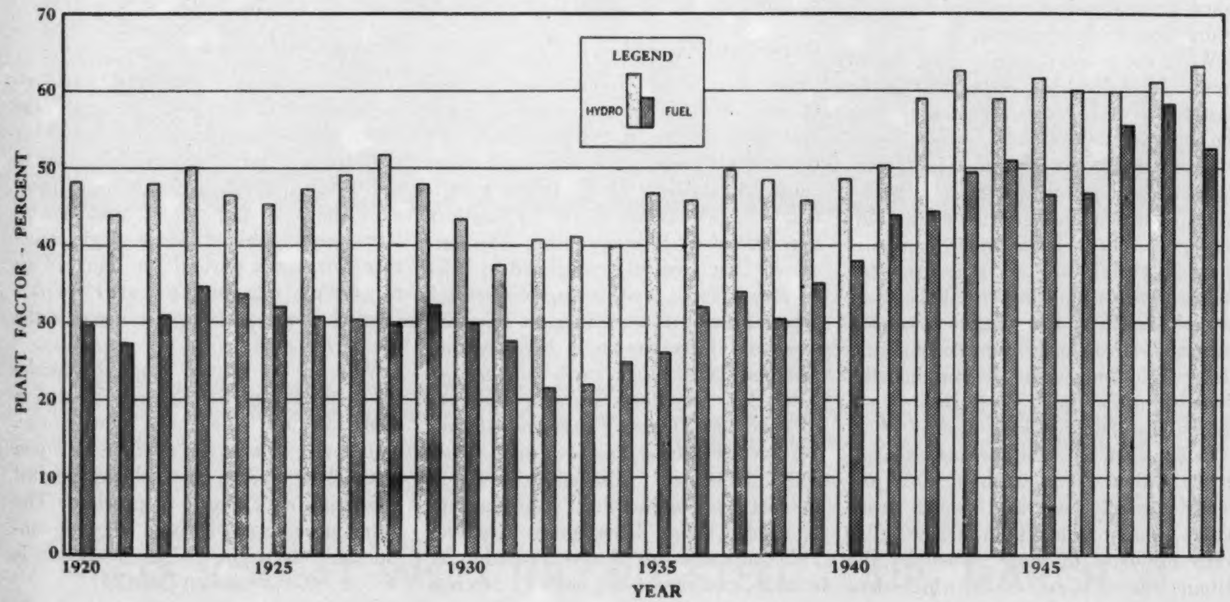
Figure 3 traces the development of public utility hydro capacity in this country since 1920, segregated by ownership class. The trend in total capacity shows two distinct periods of capacity growth, the first extending from 1922 to 1931 and the second from 1935 to the present with a slight break in the two years immediately following World War II.

The lower curves explain these two growth periods in a very significant manner. Growth during the first period was almost entirely that resulting from construction by privately owned public utilities; that since 1935 has been caused almost entirely by public agencies. The federal government has dominated the growth during this latter period and construction by other public agencies, cities, states, power districts, cooperatives, etc., has been relatively insignificant.

The growth of privately-owned hydro capacity from 1931 until 1947 has been insignificant, amounting to only about 700,000 kilowatts, an increase of only about 8.5% in 16 years. Since the war there has been a revival of interest to

(Continued on Page 14)

FIGURE 2



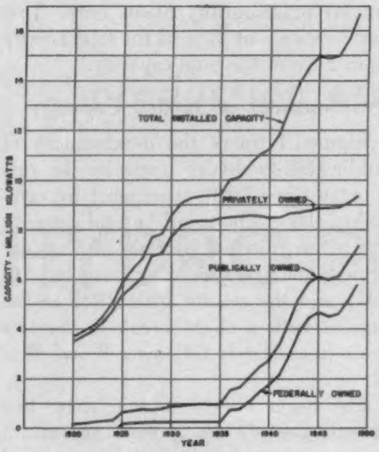


FIGURE 3

some extent by privately owned public utilities in new hydro-electric projects. In the past two years nearly 500,000 kilowatts have been added and perhaps twice that amount are under construction.

Federally owned hydro power was practically non-existent prior to 1935 when Hoover Dam began to produce power. The only federal project of any significance prior to Hoover was Wilson Dam at Muscle Shoals in Alabama, started as a World War I project and placed in operation in 1925. Following Hoover Dam came the great developments of the Tennessee Valley Authority and the Columbia River developments of Bonneville and Grand Coulee. In recent years the Department of the Army has taken an increasingly active interest in hydro-electric development.

While the graph does not show the increase in federal capacity during the past two years, it is safe to assume that the increase in publicly owned hydro was almost entirely federal. Figures are not available to indicate the total hydro capacity which the agencies of the federal government have under construction, authorized, or requested for authorization from Congress. This figure probably is twice the roughly 6,000,000 kilowatts now owned by the federal government inasmuch as planned installations in the Columbia River Basin alone amount to 8 million kilowatts.

In contrast, the fuel burning capacity in the United States is about 90% privately owned. Federally owned steam plants amount to less than 500,000 kilowatts exclusive of those owned by the Atomic Energy Commission which data is classified information. Most of this known capacity is owned by the TVA. That agency is currently engaged in a large expansion of steam capacity. Other federal agencies will doubtless follow with steam capacity to firm up their dominantly hydro systems and for such special uses as atomic plants, large wind-tunnel installations, and other military needs.

From the above, it would seem that any discussion of hydro power economics, insofar as the future is concerned, should be confined primarily to that of federal projects. However, this paper will be confined to hydro as constructed by private financing which, of course, includes both private utility companies and most or all non-federal public agencies. Furthermore, the same basic principles will apply to the very large hydro-electric development which can be expected abroad within the next generation. Much of this foreign construction will proceed with the aid of American technical knowledge and capital.

Components of Hydro Plants

Before entering into a discussion of plant costs, it is well to get clearly in mind a visualization of the principal components of a hydro-electric project. A hydro-electric development includes in some form a water diverting structure, water conductors to carry water to the wheels, turbines and governors, generators, control and switching apparatus, equipment housing, transformers, and transmission lines to the load center.

Dams and Reservoirs

The dam is used to create all or part of the head on the turbines and as a means of diverting the flow into the water conductors. It may vary from a simple diversion structure to one with a height of 600 feet or more. In length it may extend up to many miles. The Petenwell Dam, recently completed in Wisconsin, is about 8 miles long. Structural types, classified according to material used, are fill and masonry. Fill construction may use either earth or rock or both. Masonry dams are almost always of concrete. Dams of steel and of timber have been used with low, small structures. In some rare instances involving natural lakes, an artificial dam may not be needed. High dams, unless they provide some measure of flow regulation by storage, can rarely be justified. Storage implies storing water in the reservoir behind the dam on a seasonal basis; i.e., flood waters during wet periods are retained for release during low flow periods. In contrast, pondage implies flow regulation over a period of a day or week for load factoring purposes. Water is held during off-peak periods for maximum generation during the hours of peak load demand. The volume of water required for pondage is relatively small compared to the reservoir requirements for a storage plant. Some optimum storage reservoirs have a useable volume adequate to almost completely regulate the river. Such reservoirs provide "hold-over" storage in which flows from wet years may be held over for release during dry years. Nearly all hydroplants have a reservoir volume adequate for at least some measure of pondage.

An accessory to the dam is the spillway. The design of this feature must be adequate to pass the largest probable flood without danger to the structures. This requirement in the United States is subject to approval by the Department of the Army for non-federal projects. Their requirements today are universally much larger than was the common practice in this respect twenty years ago. In quite a few instances, the spillway is a separate structure from the dam and may be installed in a low saddle along the reservoir rim or be incorporated with a diversion tunnel. Regulation with gates is usually more economical and satisfactory than a simple uncontrolled overflow structure.

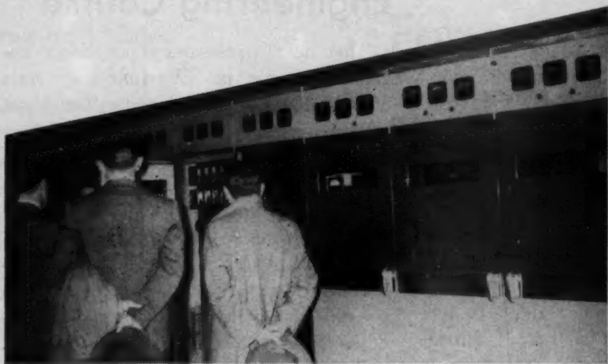
Water Conductors

Trash racks and gates are nearly always placed in the intake leading to the water conductors. The water conductor may involve only a penstock leading to the turbine. With many low head projects, the intake, penstock and powerhouse are combined into a single structure forming a part of the dam. With higher projects, the penstocks pass through the dam to a powerhouse at the toe of the dam.

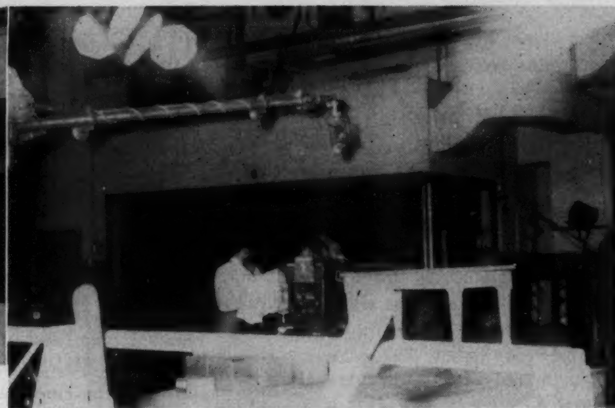
Water is conducted from the intake to a surge tank or forebay located a short distance above the powerhouse. This water conductor may be an open channel or Flume, or a closed conduit consisting of a tunnel or pipeline. The latter must always be used where a considerable drawdown of the reservoir is

(Continued on Page 26)

WSE tours a television station



1.

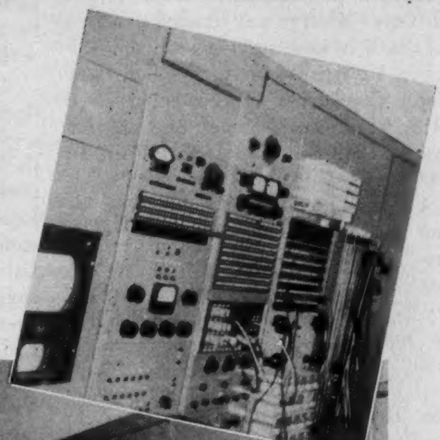


2.

Close to 250 WSE members and guests looked behind the screens of television station WNBQ, on two recent tours. Even the deserted studios at the Merchandise Mart took on a busy appearance as excursioners watched the cleaning of the TV cameras' powerful lenses and learned what camera settings NBC prefers. At the transmitter, Mr. W. F. Lanterman of WNBQ and WSE explained the equipment and the process of getting a program on the air.

4.

3.



1. WSEers listen while WNBQ engineer explains workings of transmitter panel, used for TV and FM sending.

2. WNBQ's largest studio, used for Garroway At Large and Wayne King Show, looks naked minus scenery, actors.

3. Excursioner points out feature of NBC's central control room television equipment. Three screens can show programs originating from any NBC station. Inset: Closer view of control room.

4. Transmitter engineer demonstrates how the Console works. Console controls both TV and FM.

SEE YOU AT WSE's INLAND-STEEL TOUR, MARCH 31

memos on WSE members

No sooner had February come than it was gone. No sooner had our office records been typed than they were changed. WSE members changed from commencement robes to business suits, and from business suits to uniforms.

This month headquarters was notified of losing three of its members to the armed services. First was **Ramon A. Klitzke,** formerly a fire insurance inspector with the Indiana Rating Bureau in Indianapolis. Ray is now a private stationed at Valley Forge Army Hospital, Phoenixville, Pennsylvania.

Harold C. Conners, a major in the Air Corps Reserve was recalled to active duty and is now serving with the 437 Troop Carrier Group in the Far East. Major Conners, a WSE member since 1946, had been manager of sales for Graver Tank and Manufacturing Co. in Chicago.

A young member to receive his degree and Navy commission at the same time was **Raymond D. Johnson.** Ray was graduated from Illinois Tech, January 27, with a B.S. in Civil Engineering. As members of the school's ROTC group, he received the commission of Ensign in the U. S. Navy upon graduation. He has been ordered to report to the East for active duty.

WSE wishes these three members and all its other members in the armed services the best of luck.

A non-resident member from Albuquerque, New Mexico has moved to the Chicago area to become a specification writer with A. J. Boynton Co. **Fred A. Sharring** was previously associated with Eidal Manufacturing Co. as a mechanical engineer. WSE is glad to have Fred close to headquarters and hopes he'll survive the climate change.

Ernest R. Techau, formerly vice president of Myer, Inc., is now associated with Jack Rich, Inc., industrial and commercial painting contractors in Chicago. Mr. Techau is chief engineer and consultant on color harmony and paint materials for various types of surfaces exposed to unusual and unique conditions.

Another change of business affiliation is that of **Rowland M. Davis.** Mr. Davis had been construction superintendent for Sumner S. Sollitt & Co. He now works for LaSalle Construction Co. in the same capacity.

A member to leave the Chicago area is **Daniel A. Johann.** Daniel has been transferred and elevated to the position of sales manager, Roots-Connersville Blower Corp. with factory and headquarters at Connersville, Indiana. Mr. Johann was formerly Roots-Connersville's district manager for Chicagoland.

Another transfer from resident to non-resident membership is that of **James T. Pruet.** Mr. Pruet, previously an engineer with American Meter Co., Inc., in Chicago, has traveled southwestward to the Texas country, as an engineer with Trunkline Gas Co. in Houston.

WSE resident- non-resident statistics fluctuate back and forth. The records seem to show that when a member leaves the local resident area, a non-resident transfers to Chicagoland. This time it's **Leon Urbain,** formerly a non-resident member from southern-most Illinois. Mr. Urbain comes to Chicago as a structural engineer with A. J. Boynton Co. He had been associated with the Hazlett and Erdal office in East St. Louis.

John MacLennan, formerly with the Visking Corp. is now a structural engineer with International Mineral and Chemical Corp.

Three local changes between main offices and branch offices were reported last month. **Charles W. Walker** now reports to work at Illinois Bell's general offices at 208 W. Washington. Mr. Walker, area construction superintendent, had been division construction superintendent of the telephone company's northside branch.

Administrative engineer of the Public Service Company of Northern Illinois, **M. E. Lukey,** has been transferred from the company's Glencoe office to company headquarters at 72 W. Adams.

Trading addresses with Mr. Lukey is **Irwin R. Lietzke.** Mr. Lietzke, an engineer with the Public Service Co. and formerly located at the main office, now has the Glencoe office mailing address.

Lloyd F. Lamm, is now vice president and general manager of Chicago Thrift-Etching Corp. Mr. Lamm formerly held the same title with the Etching Co. of America.

Plan Professional Engineering Course

The next professional engineer refresher course is scheduled to start March 13 and to continue for eight weeks, ending shortly before the state examination.

Sponsors of the refresher course for professional engineers are WSE, the four founder societies, AIEE, AIME, ASCE and ASME and the Illinois Engineering Council. The course is given in conjunction with the University of Illinois, Division of University Extension.

Tuition for the 16 meetings of two hours each will be $11.50 payable at the time of registration. Classes will meet each Tuesday and Thursday at 7:00 p.m.

Registration for the course will be handled the first night of class in Room 65, at Navy Pier. For additional information engineers should contact Mr. T. H. Dekker, Extension Division, Illini Center, LaSalle Hotel, Ra 6-7750, or WSE headquarters, Ra 6-1736.

Open Civil Service Exams to Engineers

The Illinois Civil Service Commission has announced open-competitive examinations for Architectural Aide, Architectural Draftsman I through IV, and Civil Engineer I through V for employment with the State of Illinois. Final date to apply is March 23.

State residence is not necessary for Architectural Aide and Architectural Draftsman I, and Civil Engineer I and II.

Desirable qualifications for Architectural Aide include college graduation, with a major in architecture or structural engineering. Architectural Draftsmen I through IV should be college graduates with progressive amounts of responsible experience.

Civil Engineers I should be college graduates with major courses in civil engineering. In addition, Civil Engineers II-V should have progressive amounts of responsible experience.

Further information and application forms may be obtained from the Illinois Civil Service Commission, Armory Building, Springfield.

Crerar Library

News and Notes

The development of a science center around the Crerar Library is carried another long step forward by the signing of a lease by the Chicago Medical Society for offices on the ninth floor of the Library Building. Remodeling is in progress, and the Society will occupy its new offices about the first of May.

This move brings to 84-86 East Randolph Street three of the largest scientific societies in the Midwest—Chicago Medical Society, Chicago Section American Chemical Society and Western Society of Engineers. Other societies also located in the Library Building at "86" are the Institute of Medicine and the Chemists Club.

Members of WSE are familiar with the Crerar collections in the physical sciences and all branches of engineering. It may not be so generally known to them that Crerar is also the largest medical library in the Midwest. The foundation of the Medical Department came through the purchase, in 1906, of the medical collection from The Newberry Library, and of the transfer of the library of Dr. Nicholas Senn, which had been given earlier to Newberry. Extensive additions have been acquired through the years, and the collections now number about 140,000 volumes.

As in the physical sciences and engineering, the greatest strength of the medical collections is in full sets of periodicals, and more than a thousand titles are added to currently.

The book collections in medicine, however, are also rich in the great historical classics, due primarily to the Senn Collection and numerous other gifts which have come to the Library through the years. Gifts also contributed greatly to the growth of the collections in current publications. The most notable contributions available for the purchase of books during 1951 are grants from the Chicago Heart Association, the Illinois Division American Cancer Society and the Chicago Medical Society.

Western Society To Sponsor Forum For Young Engineers

Plan Training Course to Acquaint Juniors with Long-View of Business

A new and long-needed plan, beneficial to both industry and the young engineer, has been initiated by the Western Society of Engineers.

WSE will sponsor the Young Engineers Forum, a series of six dinner meetings assigned to various phases of industry, during March, April and May. "Engineering in Chicago Industry" will be the topic of the Forum, and one outstanding engineering leader in the field of utility, oil, railroad, steel, general manufacturing and construction will conduct each meeting.

Each talk will be relatively short and the meeting will then be open to questions which will be submitted on the basis of the individual table groups who will agree on questions among themselves.

The Society recognizes that the young engineer, just entering business, has little time to develop a better understanding of the general field of engineering, and it wants to bring to their specialized engineering work a better understanding of the general engineering field. By necessity, the young engineer seldom has the chance to view his future with a broad objective. Western Society of Engineers, plans to give the young engineer this opportunity.

The objective of this series of meetings of Western Society is to provide an opportunity to business firms and to qualified young engineers for expanding the latter's knowledge of engineering in the major lines of business in the community, and to provide an opportunity for discussion of these general problems with experienced engineers.

Meetings are scheduled for March 13, March 27, April 10, April 24, May 8 and May 22, and are to be held in the WSE dining room. Open to 100 engineers, the majority of the Forum will be non-members sponsored by business firms employing them, or sponsored by a present Western Society member. The remaining places will be opened for registration by present WSE Associate Members on a "first apply" basis. These engineers must have qualifications (either by education or experience) making them eligible to Associate Membership. Although there will be no fixed age limit, the Forum will be of greatest value to those engineers who have been out of school no more than five to ten years.

The fee for the series, including dinner tickets, will be set at $25 per nominee. This fee is comparable with other fees paid by industry for similar training seminars. WSE will, out of this fee, pay the cost of the dinners and other meeting expenses.

The young engineer will be issued a guest card for the period of the Forum, which would entitle him to full use of the Society's program and facilities during that period.

Dr. Gustav Egloff, has been appointed chairman of the General Committee for Planning and Coordinating Programs, and Mr. W. R. Marston will act as chairman of the Committee on Physical Arrangements.

The meetings will be presided over by a chairman designated by the general committee.

First Forum speaker will be William V. Kahler, president of Illinois Bell Telephone Company and past president of the Western Society of Engineers. Mr. Kahler will open the Forum on March 13, and other prominent Chicago engineers will continue the WSE plan to familiarize young engineers with the value of community participation in building a well-rounded career.

Two Western Society Members Receive Award, Appointment

Samuel R. Lewis, WSE life member, consulting mechanical engineer of Chicago, and the author of several classic textbooks on engineering as well as numerous technical papers and engineering articles, has been awarded the 1950 F. Paul Anderson Medal of The American Society of Heating and Ventilating Engineers. The medal was awarded for "outstanding contributions to the advancement of heating, ventilating and air conditioning."

Samuel Lewis

Mr. Lewis was born in Ottawa, Ill., July 14, 1878. He was graduated from Ottawa High School in 1894 and continued his education in the International Correspondence Schools for which he was later to write texts in heating, ventilating and air conditioning which have been recognized as basic in their field.

Mr. Lewis was cited by the society for his "skill in engineering, advancement of the profession through laboratory and field research, professional ethics, inspirational help to younger members of the profession and a complete frankness in sharing his experience and knowledge for the benefit of the profession."

Responsible for the first use of a number of advanced methods which have since become accepted practice in the field, Mr. Lewis is the author of "Air Conditioning For Comfort," one of the first textbooks on the subject, published in 1932, which has been widely used both by practicing engineers and in schools. Other texts of his are "Railway Air Conditioning," Heating, Ventilating and Air Conditioning," "Piping For Seagoing Vessels," "Plumbing," and "Air Conditioning and Refrigeration," written in collaboration with Prof. Burgess H. Jennings (WSE), chairman of the department of mechanical engineering, Northwestern University.

Mr. Lewis, a life member of the Western Society of Engineers, has been very prominent in the activities of professional engineering societies. He is a founder of the ASHVE's first chapter, and past president of that chapter. He is also a member of the American Society of Refrigerating Engineers, the National District Heating Association and the Chicago Association of Consulting Engineers.

Mr. Ralph S. Peterson (WSE), line design engineer with Commonwealth Edison Co., has been appointed chairman of the Engineer Group of the Red Cross Fund Raising Campaign for the year 1951. The appointment was made by J. Harris Ward, secretary of the Commonwealth Edison Co. and chairman of Section "D" (Building, Fuel and Public Utility Groups) of the Business Division of the Red Cross fund raising organization.

Ralph Peterson

Mr. Peterson joined the Western Society of Engineers in 1943 and is best remembered by WSE for his outstanding work on the Membership Committee in 1947-48. During that time, a greater number of new members was enrolled than in any previous year in the Society's long history.

Therefore, if past performances are any indication of the future, Ralph Peterson's appointment for getting out engineers' contributions to the Red Cross is, indeed, commendable.

13th Midwest Power Conference Slated for April 4, 5, 6.

The Thirteenth Annual Meeting of the Midwest Power Conference will be held on April 4, 5 and 6 at the Sherman Hotel in Chicago. Twenty-six technical and general interest sessions, three luncheons and an All Engineers' Dinner, on April 5, will be packed into the Conference agenda. The technical sessions will be devoted to subjects covering all phases of power industry, from Jet Propulsion to Gas Turbines.

Sponsored by the Illinois Institute of Technology in cooperation with nine midwestern colleges and universities and nine local and national engineering societies, the Conference offers an opportunity to all persons interested in power to meet annually for a mutual study of the problems.

James D. Cunningham (WSE), president, Republic Flow Meters Company, will open the Conference on April 4. Henry T. Heald (WSE), president, Illinois Institute of Technology will give the welcoming address.

Western Society of Engineers will sponsor a Conference luncheon at 12:15 p.m., April 6, in the Porterhouse of the Hotel Sherman. Mr. H. P. Sedwick, WSE president, and vice-president of the Public Service Company of Northern Illinois, will act as chairman of this luncheon meeting. Col. John Slezak (WSE), president of Turner Brass Company, will speak on "The Engineering Mind in Business."

For additional information, write Edwin R. Whitehead, Conference secretary, Illinois Institute of Technology, Technology Center, Chicago 16, Illinois.

Engineers Face Jobful Future

There's no doubt of the future of present day engineering graduates. Of the 550 students who recently received their degrees from Illinois Institute of Technology, almost 25% of them had been called for military or naval service. The other 75% were snapped up by engineer-short industry without any pavement pounding.

"Commencement has come to mean just that, a beginning," Raymond D. Meade, Institute placement director, said. "They graduate Saturday and begin work Monday morning."

"During the past semester, more than 90 companies visited the campus seeking prospective graduates. Some students had as many as six offers. Many were hired on-the-spot. Salary levels have increased more than 10% in the past four months. The present average starting wage is from $290 to $315."

What is true at Illinois Tech is typical of the nation's engineering colleges. Major defense industries have notified the nation's engineering societies that their technical manpower needs are becoming more acute each day.

To relieve some of the strain and assure efficient use of technical personnel, five national professional engineering societies have established the Engineering Manpower Commission and have adopted a program to aid the government, armed services, and industry.

"A major service of the group will be to advise government agencies in obtaining maximum use of technical personnel," explained Dr. John T. Rettaliata (WSE), vice president and dean of engineering at I.I.T. and vice president of the ASME.

The major task facing the EMC at this time is educating high school seniors to draft regulations and interesting them in engineering.

According to Dr. Rettaliata, "High school students have adopted a 'What's the use?' attitude in regard to all higher education, and high school teachers and counselors have done little to offset this feeling."

Under the present draft laws, a student is guaranteed deferment for the school year in which he receives his draft notice.

He is guaranteed the right to select any branch of service even after taking his draft physical.

He has the opportunity of joining an ROTC group which will guarantee a full four-year course if he will accept a commission and serve for two years after graduation.

WSE Applications

In accordance with the By-laws of the Western Society of Engineers, the following names of applicants are being submitted to the Admissions committee for examination as to their qualifications for admission to membership into the Society in the various grades, i.e., Student, Associate, Member, Affiliate, etc. All applicants must meet the highest standards of character and professionalism in order to qualify for admissions, and each member of the Society should be alert to his responsibility to assist the Admissions committee in establishing that these standards are met. Any member of the Society, therefore, who has information relative to the qualifications or fitness of any of the applicants listed below, should inform the Secretary's office, 84 E. Randolph St., RA ndolph 6—1736.

134-82 George H. Lancaster, Specification Engineer, Chicago Transit Authority, 79 W. Monroe St.

135-82 Bernard L. McGinnis, 7905 S. Morgan St., attending Illinois Institute of Technology.

136-82 James C. Spence, Jr., (Trsf.), Junior Engineer, The Peoples Gas Light & Coke Co., 122 S. Michigan Ave.

137-82 Edward V. Gallagher, 2638 N. Lamon Ave., attending Illinois Institute of Technology.

138-82 Eugene R. Lewis, Division Industrial Relations Mgr., Public Service Co. of Northern Illinois, Skokie Highway & Dundee Rd., Northbrook, Ill.

139-82 Werner E. Rohr, 5141 W. Deming Pl., attending Illinois Institute of Technology.

140-82 James C. Schindler, Senior Draftsman & Designer, Leitner Equipment Co., 2326 S. Canal St.

141-82 Marvin L. Bruckner, 8151 S. Colfax Ave., attending Illinois Institute of Technology.

142-82 Nicholas E. Kob, Sales, Cushing Co., 139 N. Clark St.

143-82 Earl G. Abbott, Dist. Mgr. Central Station Div., General Electric Co., 840 S. Canal St.

144-82 Peter Kocsis, Jr. (Trsf.), 1330 Ardmore Ave., attending University of Iowa.

145-82 Wilbur B. Barber, Division Industrial Relations Mgr., Public Service Co. of Northern Ill., 22 W. Cass St., Joliet, Ill.

146-82 Robert A. Trumpis (Rein.), Chief Consulting Engr., Trumpis-Collar & Associates, 146 W. 37th Pl., Los Angeles 7, Cal.

147-82 Harold A. Bergen (Trsf.), Engineer-Editor, Stemar Company, 35 E. Wacker Dr.

148-82 Arthur W. Ender, Civil Engineer I, Department of Subways & Superhighways, 20 N. Wacker Dr.

149-82 Andrew P. Scittine, 116 N. 21st Ave., Melrose Park, Ill., attending Illinois Inst. of Tech.

150-82 Willis E. Dake, Appraisal Engineer, International Minerals and Chemical Corp., 20 N. Wacker Dr.

151-82 Clifford R. Billimack, Assist. Supt., Serv. & Meter Dept., Commonwealth Edison Co., 72 W. Adams St.

152-82 Henry W. Coffman, Industrial Agent, New York Central System, LaSalle St. Station.

153-82 Matthais B. Schaeffer, Officer & Secy., James, Schaeffer & Schimming, Inc., 228 N. LaSalle St.

154-82 Benton B. Gallup (Rein.), Senior Engr., Construction Dept. Commonwealth Edison Co., 72 W. Adams St.

155-82 Thaddeus C. Purzycki (Trsf.), Sales Engr. Trainee, Hooper Green Co., 407 S. Dearborn St.

156-82 Anthony M. Ricci, Superintendent, Childs & Smith, 20 N. Wacker Dr.

157-82 Clinton O. Willson, Supt., Service & Meter Dept., Commonwealth Edison, 140 S. Dearborn.

Three Sections Nominate 1951-1953 Directors

The Nominating Committees of three Sections, the Gas, Fuels and Combustion Engineering Section, the Hydraulic, Sanitary and Municipal Engineering Section, and the Traffic Engineering and City Planning Section, have nominated two members each as the regular ticket for Directors of these Sections, for a term of three years beginning June 1, 1951.

Nominees for the Gas, Fuels and Combustion Engineering Section are as follows:

Paul V. Henehan, Civil Engineer, The Peoples Gas Light & Coke Co.

M. G. Markle, Gas Engineer, Public Service Company of Northern Illinois.

Nominees for the Traffic Engineering and City Planning Section are:

James L. Foley, Jr., Traffic Engineer, Chicago Plan Commission.

Matthew C. Sielski, Director, Safety and Traffic Engineering Department, Chicago Motor Club.

Nominees for the Hydraulic, Sanitary and Municipal Section are:

W. W. Mathews, Superintendent, Gary Sanitary District.

Russell A. Thompson, Principal Engineer, Corps of Engineers, U. S. Army.

Other Corporate Members may be nominated by petition signed by ten Corporate Members of the Society, provided acceptance of these nominees has been secured in writing.

Directors of these Sections will be elected at the Section meetings, as follows:

Traffic Engineering and City Planning —March 12,

Hydraulic, Sanitary and Municipal Engineering—April 16,

Gas, Fuels and Combustion Engineering Section—April 23.

The announcement of nominations of directors of other Sections will be published in the April issue of the *Midwest Engineer*.

Give Pointers on "Societicide"

We are reprinting from the *Missouri Alumnus* a very penetrating analysis of organizational suicide, "Ten Ways to Kill An Organization." We trust it doesn't apply to any WSE members.

1. Don't come to the meetings.
2. If you come, COME LATE.
3. If the weather doesn't suit you, don't think of coming.
4. If you attend a meeting, find fault with the work of officers and other members.
5. NEVER ACCEPT AN OFFICE, it's easier to criticize than to do things.
6. Nevertheless, feel hurt if you are not appointed on the committee; but if you are, do not attend the committee meetings.
7. If asked by the chairman to give your opinion on some matter tell him you have nothing to say. After the meeting tell everyone how things ought to be done.
8. Do nothing more than is absolutely necessary, but when members roll up their sleeves and willingly, unselfishly use their ability to help matters along, say that the organization is run by a clique.
9. Hold back your dues as long as possible—OR DON'T PAY AT ALL.
10. Don't bother about getting new members. LET SOMEONE ELSE DO IT.

Wrong Roads and Missed Chances—Some Ancient Radio History

(*Continued from Page* 5)

Company, C. S. Franklin. Following up some work of Marconi for the Italian Army with short wave directive beams, Franklin established a telephone circuit between London (Hendon) and Birmingham in 1920, on the extremely short wave of 15 meters. That wave length was chosen—not for any expected advantage in transmission—but because it was easy to set up a reflecting antenna for waves of that order, and because loss of range, i.e., the "daylight effect" does not occur over so short a transmission path (100 miles). The Hendon and Birmingham transmitters had effective radiated power of about 4 kilowatts, and the system worked well. The significance of the Hendon-Birmingham circuit in this chapter of radio history will appear presently.

The radio amateur comes into the story at this point. American and British amateurs had been talking for years about organizing a test to determine whether the wave lengths on which they were allowed to work—the commercially "useless" ones of 200 meters and under—could span the Atlantic—during the hours of darkness, of course. Such a test was finally organized in 1920, on the 200 meter wave length. It failed. In the next year, another test was organized. Though all prophesies were that it too would fail, in fact a score of United States amateur call letters were identified in the British Isles in December 1921, two of them from stations with power of less than 100 watts; and one of the stations, Station IBCG in Greenwich, Connecticut, succeeded also in transmitting a complete message.

But the signals could be received only during the night hours of the Atlantic path; they ended with sunrise at its eastern end and did not reappear until after sunset at its western end. While the results caused a flurry of interest for a time, it soon died down, since a system that would work only at night was of no commercial importance. Though everyone was surprised that a 200 meter wave could span the Atlantic, neither the commercial companies nor those who took part in the tests were stimulated to investigate the shorter waves further. I took part in the construction of the IBCG transmitter and also in the decision to dismantle it after the test, when the question of further investigation was discussed. Why investigate something with so fatal a defect—it could work only part of the time? Marconi seems to have been the only man whose imagination was fired by the spanning of the ocean by the stations of the amateurs.

In a paper presented before the American Institute of Electrical Engineers and the Institute of Radio Engineers in New York City in June 1922, Marconi told about some of his recent work in radio, including the work for the Italian Army with directive beams and the 15 meter Hendon to Birmingham telephone circuit. He suggested that radio has perhaps got into a rut by confining practically all its research to the long waves, and that more attention should be given to the shorter waves; and he summed up his remarks on the subject with these prophetic words: "I have brought these results and ideas to your notice as I feel —and perhaps you will agree with me— that the study of short electric waves, although sadly neglected practically all through the history of wireless, is still likely to develop in many unexpected directions, and open up new fields of profitable research."

Upon his return to England, Marconi began a series of classic experiments from the historic Poldhu site, which took him on a cruise in his yacht "Elettra" to the Cape Verde Islands in the South Atlantic during the spring of 1923. He had set up a transmitter at Poldhu on the longest "short" wave for which it was then practicable to build a reflecting beam antenna—97 meters. He listened to the Poldhu signals as he cruised south, and found them to be extraordinarily good. In the Cape Verde Islands, over 2,500 miles from the transmitter they were far better than any signals that had ever been received over a comparable distance from a high power long wave station. Marconi reported that even when the power at Poldhu had been reduced to one kilowatt, its signals at night were still better than those received from the highest powered transoceanic stations in the British Isles. While the usual disappearance of the signals during daylight hours occurred, Marconi observed that the signals lasted for a time after sunrise at Poldhu and that they became audible again before darkness had set in at the Cape Verde Islands.

That observation led him to suspect that some new phenomenon was present in the short wave band; and after his return to England he laid out a program of further experimentation for the following year, when he would compare the signals at 90 meters with those on a number of shorter wave lengths, down to the region of 30 meters. In 1924, he cruised through the Mediterranean to the coast of Syria; and in Beyrouth harbor in September of that year he made the astounding observation that the signals on the 32 meter wave from Poldhu, some 2,400 miles away, held in throughout the day—they were in fact as good as the night time signals, whereas a longer wave of 92 meters, on the same power, behaved as at the Cape Verde Islands. What Marconi was observing was transmission by reflection from that ionized layer of the upper atmosphere which later became known as the F_2 layer, after years of observations had laid bare the mechanism by which the effect was produced. But as with Marconi's first discovery, his practical achievement was years ahead of the theory.

Returning to England within a month's time, Marconi sent notification of scheduled transmissions on 32 meters to Argentina, Australia, Brazil, Canada and the United States; and at the appointed times the daylight signals were received in all those countries. From the end of the earth—far-off Australia— came a report of successful reception for 23½ hours out of the 24.

These astonishing results became still more astonishing when it is remembered that Marconi was using only a few percent of the power of the transoceanic long-wave stations, and was unable to take advantage of his directive beam antenna because of the diversity of the paths of transmission to the various receiving points.

As sometimes happens with radically new discoveries, the significance of Marconi's results was not generally appreciated, at first, outside his own organization. As in the case of his original discovery, what he had done was too far out of line with established teachings to be accepted in advance of a physical demonstration of the result. But while

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Attention All Corporate Members

Proposed Amendment To the Constitution of the Western Society of Engineers

In accordance with Article XV, Section 2, of the Constitution of the Western Society of Engineers, the following notice is printed, and herewith mailed.

The proposed Amendment to the Constitution of the Western Society of Engineers, as set forth below, has been submitted by 25 Corporate Members, in accordance with Article XV, Section 1.

Subsequently, the proposed Amendment was submitted to the Board of Direction and referred to the Amendments Committee, which latter body reported to the Board of Direction at its regular February meeting. The proposed Amendment was approved by the Board of Direction of the Western Society of Engineers, upon recommendation of the Amendments Committee.

Present Constitution

Article V—Membership

Section 7. A Student Member shall be registered in an undergraduate or a graduate engineering curriculum approved by the Board of Direction of the Society and shall be pursuing a course of study in preparation for the engineering profession.

He shall transfer to Member or Associate Member grade within one year after termination of student work or his membership in the Society shall terminate.

Article VII—Fees and Dues

Section 1. The fees and dues for the various grades of membership shall be as follows:

	Entrance Fee	Annual Dues Resident	Annual Dues Non-Resident
Honorary	None	None	None
Member	$20.00	$20.00	$13.50
Assoc. Member (Age 30-35 years)	15.00	15.00	10.00
Assoc. Member (To age 30 years)	10.00	10.00	6.50
Affiliate Member	16.50	16.50	11.50
Student Member	None	3.50	3.50

Proposed Amendment

Article V—Membership

Section 7. A Student Member shall be registered in an engineering or a graduate engineering curriculum approved by the Board of Direction of the Society and shall be pursuing a course of study in preparation for the engineering profession.

He will become an Associate Member automatically upon graduation from said approved course, which graduation is properly attested by a statement from the school or college.

Article VII — Fees and Dues

Section 1. The fees and dues for the various grades of membership shall be as follows:

	Entrance Fee	Annual Dues Resident	Annual Dues Non-Resident
Honorary	None	None	None
Member	$20.00	$20.00	$13.50
Assoc. Member (Age 30-35 years)	15.00	15.00	10.00
Assoc. Member (To age 30 years)	10.00	10.00	6.50
Assoc. Member (Transfer from student member)	None	10.00	6.50
Affiliate Member	16.50	16.50	11.50
Student Member	None	3.50	3.50

Meeting Call

This is to notify all Corporate Members that at the March 26, 1951, meeting of the Western Society of Engineers, at its headquarters, the above Amendment shall be the order of business for discussion in accordance with Article XV, Section 2, of the Constitution of the Western Society of Engineers.

Announce Regular Ticket for 1951-52 Officers

The regularly appointed Nominating Committee of the Western Society of Engineers submitted the following nominations to the Board of Direction at its regular February meeting. The report of the Nominating Committee was concurred in by the Board.

In accordance with Article X of the Constitution of the Western Society of Engineers, the nominations, hereinafter known as the Regular Ticket, are published below; and herewith mailed to all corporate members.

President..........Donald N. Becker
1st Vice President....Ovid W. Eshbach
2nd Vice President..Charles E. DeLeuw
Treasurer........John F. Sullivan, Jr.
Trustees for three years.........
....Albert P. Boysen, W. R. Marston

Also recommended to serve on the Washington Award Commission for a three-year term were the following: James D. Cunningham, Albert Reichmann.

Additional nominations for any office, provided for in Article X, Section 4, may be made in accordance with the provisions of the Constitution of the Western Society of Engineers, as set forth in Article X, Section 5, prior to the twentieth day of March. This form of nomination is known as a Ticket By Petition.

Members of the nominating committee are: Gustav Egloff, Charles Burdick, E. Gordon Fox, L. C. Gabbard, B. A. Gordon, John Gnaedinger and L. E. Langdon.

Production Economies of Hydro-Power

(*Continued from Page* 14)

involved as with most storage projects. The surge tank or forebay provides head regulation at times of load pickup or rejection.

Penstocks serve each unit in the powerhouse, splitting from a single conductor at some point between the surge tank and the turbine scroll case. Valves are installed in the penstocks of each unit for emergency closure, to permit unwatering the unit, or to relieve the pressure on the wicket gates and reduce leakage when the unit is out of service. The intake gate serves this same function on more closely coupled installations.

Generating Plant

The principal elements of the generating plant are the turbine and generator which are coupled directly together. Since the development of the Kingsbury bearing in 1910, the setting is almost always vertical. Horizontal settings are sometimes used with smaller units and almost always in connection with impulse wheel installations.

The powerhouse includes the substructure and the superstructure. The substructure encloses the turbine together with its scroll case and draft tube. The scroll case, except for impulse wheels, distributes the water uniformly to all sides of the wheel. The draft tube utilizes the head below the wheels, recovering the kinetic energy of the water without undue losses.

The superstructure houses the generators, control equipment, machine shop, and other miscellaneous equipment. The wall columns support the overhead crane. Virtual elimination of the superstructure with covers provided for the generators is not uncommon in milder climates and even in some severe climates where winter snowfall is not excessive. These are known as outdoor or semi-outdoor powerstations. With these types a gantry style of crane is used.

The main transformers and the circuit breakers are located outdoors in an open switchyard near or adjacent to the powerhouse, and sometimes on the powerhouse roof. The voltage is stepped up from the usual 11,000 or 13,800 generator voltage to transmission requirements.

The principal elements of a waterwheel driven generator include the stator and rotor, exciters, supports, cooling devices, and the shaft for connection to the turbine. Principal differences between the generator for a hydro unit and for a steam unit is the hydro generator's slower speed and consequently greater size for equivalent power, and its normally vertical setting. With the slower speeds, the number of pole pieces must, of course, be increased.

The various types of hydraulic turbines in common use today are the Francis Kaplan, impulse or Pelton and the fixed blade propeller type. There are, of course, other types of hydraulic prime movers, such as gravity water wheels of the overshot or undershot types, which are still commonly used in small grist mills especially in the mountainous areas of the east and south. Hydraulic turbines are classified, with respect to their hydraulic action in two main divisions, impulse and reaction. These are generally used names, but the names in themselves have little hydraulic significance.

Impulse wheels are represented in modern practice by a single type, the Pelton wheel. With an impulse turbine the available energy is converted into kinetic energy in a contracting nozzle and the water is formed into a free jet acting on the buckets of the periphery of the wheel. The water discharging from the buckets falls freely in an open pit to tailwater. The largest impulse wheel so far installed was of 70,000 horsepower. This type of wheel is generally used with heads above 200 feet. There are installations in Switzerland utilizing heads of over 5,000 feet. With the lower heads the quantity of water and consequently the unit size is rather small.

With reaction turbines the entire flow from headwater to tailwater takes place in a closed conduit system. Reaction turbines are represented in modern

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Midwest Engineer Brings WSE Foreign Traveler Close to Home

Letters from out-of-town are always welcome, doubly so are letters from as far out-of-town as London, England. The following is a reprint of a letter from WSE traveler, **Theodore Bockman,** a coordinator with Universal Oil Products, now in England.

"In the December number of *Midwest Engineer* under "Memos on W.S.E. Members," you ask to hear from out-of-towners. Perhaps I can qualify at least for a short while yet.

Have been receiving the *Midwest Engineer* regularly in London for the past eleven months, and needless to say the issues have been particularly welcome here—just like letters from home. Even the advertisements have a bit of a tonic effect.

Within the next two months I hope to wind up my engineering consulting assignment here with Trinidad Leaseholds Limited in connection with T.L.L.'s major refinery construction programme at Trinidad, B.W.I. The work involves a number of processing plants, including a large modern U.O.P. fluid Cat. Cracker.

My work is extremely interesting, and a great experience, particularly since it affords a close view of British engineering practice thru many dealings with British designers and manufacturers of oil refining equipment. It might be mentioned that this entire project at Trinidad is to be built of equipment of which about 90-95% (in value) is of U. K. manufacture.

I see that energetic Dr. Egloff of our company is still very much on the move. We met him here in London last summer during his European trip. I understand he plans another trip to Europe this spring, but we (Mrs. Bockman and I) will probably be back in Chicago (I hope) by then, where advantage can be taken of those fine W.S.E. inspection trips and Thursday luncheons which I now can only read about."

ASME Meetings

ASME Juniors will have as a speaker for their March 6 meeting Colonel Paul Armstrong, Illinois Director of Selective Service. Colonel Armstrong will talk on "Selective Service and the Young Engineer." Dinner will be held at 6:15 p.m. in WSE dining room, and the meeting will follow at 7:30 p.m. in the large auditorium at WSE headquarters.

On March 20, the Applied Mechanics section of ASME will sponsor a discussion of "Design of Gear Teeth." Mr. S. O. Bjornberg, consulting engineer with Illinois Tool Works and Anthony F. Zanis, also with Illinois Tool Works, will give an illustrated talk on gear teeth design. The meeting, will be held in the WSE Large auditorium at 7:30 p.m., will be preceded by a rendezvous dinner at 6:15 p.m.

Interior Decorating will be the theme of the ASME Ladies Auxiliary luncheon meeting on March 22. Miss Laura Welsch, Carson Pirie Scott's interior decorator will speak on that subject. The ladies are asked to assemble in the lounge of WSE headquarters at 12 noon. Luncheon will be $2.00.

Call FI 6-2990 for reservations.

Wrong Roads and Missed Chances—Some Ancient Radio History

(*Continued from Page* 21)

others hesitated, Marconi, supported by the brilliant engineering of Franklin, moved rapidly, and by the end of 1927 short wave beam transmitters were operating between England and all the principal parts of the Empire—and at speeds (100 words per minute) that no long wave transmitter or cable had ever approached. The long waves were obsolete and the cables had become a secondary means of communication.

Today, all but a few percent of the world's long distance radio communication is carried out on wave-lengths less than ¼ the length of the waves originally allotted the amateurs in the 200 meters that no one else wanted. Perhaps the best measure of the advance from the era of the "grounded" wave is that it is now routine for amateurs the world over, with a few hundred dollars worth of equipment, to communicate with each other, and the "working" of several continents in a single day is no longer the subject of comment.

We can return now to one of the great missed chances—the chance that every American amateur and radio experimenter had had to tune in the Hendon-Birmingham beam telephone as early as 1922 and discover the daylight wave before Marconi. The Great Circle course of the Hendon beam lay across Eastern Canada and the United States. The 15 meter wave, as was later found, was a better daylight wave than those in the 30 meter range, though it was not effective at night. Full information about the Hendon station was available from Franklin's and Marconi's publications, and all necessary information about the most effective means of receiving such waves —the superheterodyne—had been published.

Had any radio experimenter in the United States thought to set up a superheterodyne for 15 meters and listen for the Hendon signals during the daytime, he would almost inevitable have heard them at some time during the day and he, instead of Marconi, would have discovered the daylight wave. But no one had the imagination to set up a receiver and listen. We all "knew" too much about propagation; only a madman in those days would have proposed to receive 15 meter signals across the North Atlantic, especially during daylight hours.

There is, however, a consolation for the American experimenters who missed the chance. The master experimenter himself, Marconi, also missed it. Though for more than 20 years he had made it a practice on voyages to the United States to take along receivers to listen to his British stations, when he crossed the Atlantic in the "Elettra" in 1922 it seems not to have occurred to him to take along a 15 meter receiver and listen to Hendon. Had he done so, and turned the Hendon beam to follow the yacht, he would have discovered the daylight wave two years before he actually did.

In retrospect, no one can regret that it was Marconi who made the great discovery. A reading of his account of his cruises shows that this was no chance discovery, but the result of a careful search by the one man who was able to define the limits of his own knowledge. Marconi set out on a thorough and painstaking exploration of what lay beyond those limits, and his search was rewarded by the success it deserved. To Marconi and those who worked with him goes the credit for the great discovery that put radio in first place in the field of world communication.

It is seldom given to a man to make two great discoveries, as Marconi did. He created the practical art of radio communication; and a generation later, when the limits of its ability to conquer distance seemed to have been reached, he came along with the discovery that made world-wide radio communication a reality.

The lesson of his work is clear-cut. He did not unlock the secrets of radio by exercise of some superior reasoning process. He studied the phenomena of radio as he encountered them, with an inquiring and open mind; as he let Nature and his apparatus get the answers for him. The key to his achievement is that he was able to appreciate the limits of his own knowledge, and to doubt what others were ready to accept as dogma. For that rare ability and his infinite perseverance he gained the reward that always awaits the true discoverer—he builded better than he knew.

Hydro-Power

(*Continued from Page* 23)

practice by the Francis and propeller runners, which are the only two basic types. The propeller class is further subdivided into the fixed blade type and the adjustable blade type, the Kapalan being representative of the latter. The propeller types are inherently suitable for low-head developments. Their high speed results in savings in generator and powerhouse structure costs. The adjustable blade propeller type is a development from the fixed blade propeller. With the Kaplan wheel, the blades adjust automatically to attain high efficiency at any gate opening.

The propeller types are best suited to heads below about 100 feet while Francis units may be installed at heads varying from 50 to 1,000 feet. Heads between 50 and 100 feet, therefore, require careful analysis to determine which type represents the greatest overall economy. Largest known units currently in service are shown as 48,000 hp for the fixed blade, 74,000 hp for the Kaplan, and 150,000 hp for the Francis.

The limit in efficiency of turbine development and installation was closely approached by 1920, with little increase noticed since that year. Top efficiencies are about 93%. The great increase in specific speed, which is a speed index for comparison of all wheels, since 1922 resulted from the development of the high-speed propeller runner which permitted the economical development of large low head plants. The use of better materials and new construction methods has boosted the horsepower of the largest unit to 150,000, which is now installed at Grand Coulee.

Comparative efficiencies of the various types of units reveal that the fixed blade propeller unit has its highest efficiency at a point near full load, but drops off rapidly as the load decreases. Accordingly, it is best suited to installations where it may be operated within a very narrow load range from point of best efficiency. The adjustable blade turbine, efficiency-wise, operates as though one had available a great number of fixed blade wheels to be operated one at a time over a wide load range. Its efficiency curve, therefore, is very flat over a wide range of load conditions. It is particularly adaptable to low head conditions where the operation will be over a wide range of head and load conditions. Both the Francis and impulse turbines have reasonably broad efficiency curves, though neither is as broad as that for an adjustable blade propeller turbine.

Each type of unit has a definite place and the hydro engineer must weigh carefully his selection in order to achieve the best economic balance.

Capital Costs

It cannot be repeated too often that the cost of generating electric energy is but a small part of the cost of electric service. Widespread lack of this knowledge places most politico-economic and even technical discussion badly out of perspective. However, the cost of generation is an important item in the total cost of power. The capital cost of a development is basic to the determination of production costs. For hydroelectric developments, these costs vary widely depending as they do on such varying physical characteristics as topography, location, available head, stream flow, storage possibilities, right-of-way, and so on.

Figure 4 shows an analysis of capital costs of the privately owned public utility hydroelectric generating stations in the United States as prepared by the Federal Power Commission. The cost of 984 stations is incorporated in this analysis and thus represents virtually all the hydro of this ownership class. It should be noted that this analysis does not include the step-up substations nor transmission.

The lower series of curves represents the F.P.C. data. All costs are presented on the basis of dollars per installed kilowatt. The wide range of costs for hydro developments is readily apparent. The spread between the minimum and maximum cost stations cover a range varying from 250% for large stations to 400% for small and medium sized stations. The range for steam stations based on a comparable F.P.C. analysis is about 200% when compared with the low cost stations, regardless of size. In general, unit costs decrease both with the size of the plant and with increasing head.

It should be borne in mind, as previously mentioned, that the great bulk of privately owned public-utility hydro was constructed in the decade of the twenties. It is interesting, therefore, to get an impression as to what these 984 stations would cost if built at today's prices. In a general way, this would give us some measure of comparison between the sites being developed or proposed for development today with those previously developed. Accordingly, this author made a rather detailed study, within the limits of time and available data, of these present day costs of existing plants. This study developed an average cost ratio almost exactly three times the historic. The curve for all stations on this new basis is shown in the upper part of the curve. The outer limits of

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Hydro-Power

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the shaded areas surrounding each curve represent the average unit costs of stations having unit costs higher and of stations having unit costs lower than the average of all stations.

It does not necessarily follow that all new hydroelectric projects with unit costs falling within or below the upper shaded area can be economically justified. Local market conditions, notably the competition from federal power, particularly in the southeast and Pacific northwest, may make a project impossible to finance in one section of the country, whereas if located in, some other region it might be very attractive.

The crosses are plots of the cost, estimated or actual, of twelve developments which our company has studied within the past three years and which are economical to develop. The head range varies between 18 and 800 feet. All fall within or below the range of the 1950 duplication price range for existing developments. For all practical purposes the unit cost of all lies above the curve of maximum cost stations of the F.P.C. analysis. Therefore, the range of costs under present price conditions for new developments which are economically justified varies between $250 and $500 per kilowatt of installed capacity.

The greater range of cost for hydro plants than for steam plants results principally from the influences of topographic and geologic conditions. Whereas these factors normally represent about 15% of the total cost for steam plants, they frequently represent the basis for 75% or more of the cost of hydro plants. The range of reservoir costs with a hydro plant may vary from little more than the cost of clearing to the cost of flooding lands with a high productive

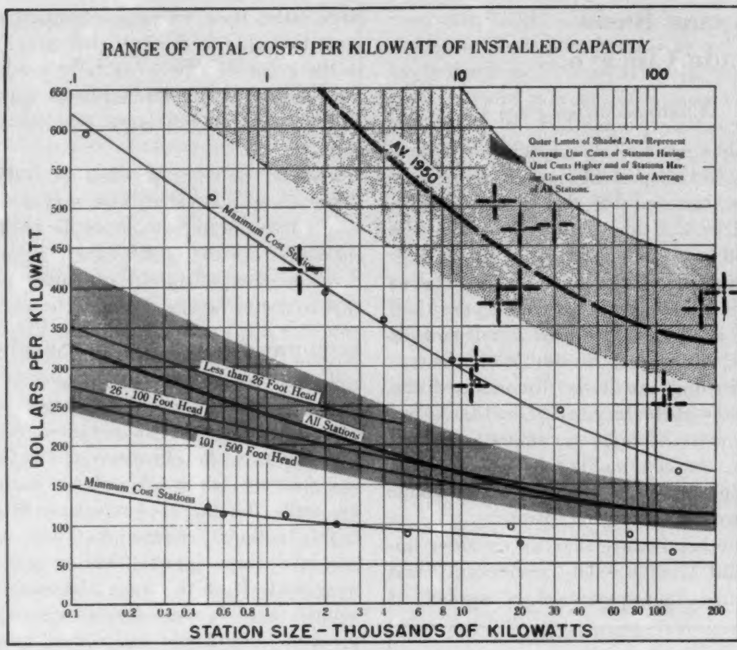

FIGURE 4

value and continuing a high degree of cultural development such as villages, railroads, highways, bridges and other public utilities. A more or less restricted damsite with sound foundations, large reservoir volume in the valley upstream with few improvements, and a concentration of head in the river bed immediately downstream almost always presents a site favorable for development. However, the volume and uniformity of flow throughout the year also has an important bearing. Particularly is this true in many of the tropical and sub-tropical regions of the world which are subject to definite rainy and dry seasons, each consuming roughly one-half of each year.

Three major human factors probably influence the cost of a development more than any others. One is the skill, largely established by experience and inherent vision, of the engineer who plans the development. Another is the foresight of the executive. Acquiring of water and land rights and even natural deposits of construction material twenty or thirty years in advance of actual construction is not uncommon among better-managed utilities. Cost savings thus achieved often mean the difference between whether or not a project is economic at the time the utility needs the additional capacity.

The third human factor of great importance is the efficiency of the construction personnel and methods. A good example of this is the low cost for underground excavation such as tunnels which

(Continued on Page 29)

Propane Buses Invade Chicago

(*Continued from Page* 10)

city bus service. We specify a fueling tank and dispensing nozzle that eliminates the need for the fueling density table or the dip tube to determine the liquid level. A small tank of about 20% the capacity of the fuel tank is installed within the fuel tank. While the fuel tank is being filled the small tank is sealed off free of liquid. At the instant the fueling nozzle is disconnected the contents of the large and small tanks are once more brought in contact with each other, thereby making it impossible to develop pressures in the fuel tank above its ordinary working pressure.

Another feature that we consider important from a safety standpoint (and the fire departments of a number of large cities have recently expressed the same thought) is the fact that propane, in the event of a fire, can only produce a torch type of fire. It can never spread and run the way a large gasoline fire can.

Finally, on the question of safety, there are check valves and excess flow valves introduced throughout the path of the fuel from the tank to the engine so that the flow of liquid or vapor to a ruptured line would be quickly sealed.

Economy From Propane Surplus

The economy of using Propane can be written almost exclusively around the comparative prices of gasoline, diesel fuel and propane. Propane comes from two sources, crude oil and wet natural gas wells. Of the approximately fifteen billion gallons produced in 1949, only two and three quarter billion gallons were sold. If all the transit buses in the country were converted overnight to use propane there would still remain unsold more than 75% of that produced.

Due to this tremendous surplus of propane the cost has remained nearly constant during the last decade with the exception of a period during 1947-48 when an unsuccessful effort was made to relate propane cost to crude oil cost. During that same period gasoline has increased roughly five cents per gallon and diesel fuel roughly the same amount. There is in this part of the country about a 6¢ a gallon spread between gasoline and propane and about a 4½¢ spread between diesel fuel and propane. The tax situation is common to all of them. By setting up the compression ratio of the Twin Coach Engine from 7½ to 1 to 10 to 1 (an increase that is well within the design limits of the engine) it is possible to get the same miles per gallon that is obtainable from ordinary gasoline. Diesel fuel with its still higher compression ratio will produce mileages 10 to 20% per gallon better than gasoline. The fleet of 51 passenger buses in our service will get between 3 and 4 miles per gallon on ordinary gasoline so that we are expecting fuel economies in the order of 2¢ a mile over gasoline and one and a fraction cents a mile over diesel fuel. Additional economies which have not been evaluated should result from a longer life of the lubricating oil since there will be no dilution and the lessening of ring piston and cylinder wall wear since there will be no wash down of the lubricant. The almost complete absence of carbon deposit should increase the life of valves and valve seats. The propane carburetor and regulator-vaporizor should be simpler to maintain than the conventional carburetor and fuel pump. Most well maintained transportation companies set up engine overhaul periods every so many thousand miles and then check oil and gasoline consumption records before actually overhauling. By this method it will be relatively easy to evaluate these anticipated plus values after a couple of years of operation. Until then evaluation will not even be attempted.

Expect Ready Public Acceptance

We expect the absence of smoke or fumes to find a very ready public acceptance. In fact this feature has been noticed and favorably commented upon in connection with the three demonstra-

(*Continued on Page* 29)

Armour Research

(Continued from Page 9)

This would prevent warehouse losses, estimated as high as a billion dollars a year. It could also stop dry-rot fungus in building materials, kill weeds, and remove sizing material from cotton goods.

There is a miniature foundry, machine shops, a laboratory where insulation materials are evaluated, and a high pressure laboratory with a press that puts a million and a half pounds per square inch squeeze on a specimen. An electronic computer can solve complex equations 50 times as fast as an able mathematician. A microtome, slicing instrument for preparing specimens to put under a microscope, can section a penny into more than 10,000 circular slices.

But among all the test tubes, all the microscopes, all the notebooks, are people, all specialists, whether they be typist or atom expert, accountant or chemist. Around the conference table or over a Bunsen burner, they are part of the Armour Plan in action.

"Part of America's future rests on the laboratory benches and drawing boards at Armour Research Foundation of Illinois Institute of Technology", says Director Leedy.

Engineers realize the invaluable job Armour has done, and depend on it to forge forward in the future.

Propane Buses Invade Chicago

(Continued from page 28)

tor buses using propane that have accumulated a total of approximately 15,000 miles in passenger service.

Everything said here has been in the nature of a prediction of what we expect of propane. A review of these predictions a couple years from now will prove extremely interesting.

Hydro-Power

(Continued from Page 28)

the Swedes have attained by technological advances and labor efficiency. This is not because of cheap labor prices, inasmuch as such prices in Sweden are comparable with those in the U. S. Comparable costs, if and when attained in the U. S. might bring some hydro projects within the limits of economic feasibility. In the U. S. the advances made in earth moving machinery and methods has resulted in keeping the unit cost of fill dam construction virtually the same as it was thirty years ago. In contrast, the cost of concrete forming has increased so greatly that it is usually less costly to construct a gravity concrete structure than a reinforced concrete structure, though 20 years ago the latter type would likely have been selected. Reinforced concrete and complicated arch construction has virtually disappeared in this country while it continues to be very popular in certain sections of Europe, especially France.

As would be expected, considering the wide cost range of hydroelectric projects, great variation exists in the percentage of total cost of a project accounted for by each of its principal components. However, the costs for lands and the water supply system, including the dam, reservoir, and water conductors, are dominant, but these items may vary up to as much as 90% of the total project cost. On the average, according to the studies of the Federal Power Commission, they amount to 70% for plants with heads under 500 feet and 80% for heads over 500 feet of the total project cost. The remaining costs, 30 and 20%, respectively, represent the power station. Not only does the proportion of the cost of reservoirs, dam, and waterways increase with head, but also it increases somewhat, on the average, with increases in the size of the station. Large, high-head stations have a very high percentage of their cost involved with these items.

(To be continued in the April issue)

Book Browsings

Books Available at WSE Headquarters

Structure Foundation Designs

Foundations of Structures, by Clarence W. Dunham. McGraw-Hill Book Co., Inc., New York, 1950, 679 pp. $7.50.

This is a very well written and practical book on the planning and design of foundations. No attempt is made to cover the field of soil mechanics, but information enough is given to show methods of exploration of the site and of determining allowable bearing pressures.

A valuable feature of the book, especially for young engineers, is the analysis of many foundation problems, giving the advantages and disadvantages of the several types of foundations considered, and the reasons for the final selection. Many problems are worked out numerically and a great number of practical suggestions are given.

Subjects treated include soils, exploration of site, bearing pressures, spread footings, foundation walls, foundations subject to overturning forces, piles, cofferdams, caissons, bridge piers and abutments, and underpinning.

The description of the exploration of the site, planning, difficulties, remedies, and final design and details of the foundation for a large smokestack is given in the final chapter, and is an interesting and informative account.

Many diagrams and pictures of actual structures and foundations add to the value of the book. It will be a valuable addition to the libraries of all engineers interested in foundations.

H.F.W., W.S.E.

Telemetering Facts Coordinated

Principles and Methods of Telemetering, by Perry A. Borden and Gustave M. Thynell. Reinhold Publishing Corporation, New York, 1948. 230 pages. $4.50.

Telemetering is a relatively new art that has grown up in the electrical age, but is only about one-half as old as the electric light and the telephone. The first practical installation of telemetering was made in Chicago about 1912. In their preface, the authors give a short definition of telemetering as the remote measurement of variable magnitudes, usually by electrical methods. They also deplore the previous absence of coordinated information, on this relatively new but greatly expanded art, as causing a hardship on prospective users of telemetering.

The authors, who are engineers of the Bristol Company, have searched the available records of their own company and 16 other manufacturers, to uncover all the different types of telemetering. They also have searched the books and publications of such learned societies as the American Institute of Electrical Engineers and the American Standards Association. Their resultant treatment of the subject is from the technical viewpoint of basic circuit components and the results obtained, rather than installation and operating methods which are always available in manufacturers' instruction books. The discussion is divided into chapters where the several basic systems are classified according to the nature of the electric variable, or signal, in the transmitting channel, such as current, voltage, frequency, position, and impulse. It continues through such modern features as carrier current, totalizing, computing, and integrating.

A small space is devoted to hydraulic and pneumatic systems of telemetering for certain purposes. The text is supplemented by (1) a well arranged bibliography of articles, books, and reports, (2) a list of patents, and (3) a list of registered trade names.

Two items in this book will be of particular interest to Chicago engineers, (1) the early uses of certain types of telemetering by the Commonwealth Edison Company, and (2) the design and scope of the Republic flow meter, dependent on the inventions of the late Jacob M. Spitzglass (Mem. W.S.E. 1920-1933) whose patents appear in the patent list.

H. H. F., W.S.E.

Follows Gilbreth System

Motion and Time Study, Principles and Practice, by Marvin E. Mundel. Prentice-Hall, Inc., New York, 1950. 475 pages. $6.65.

This book is intended to be an aid to practicing industrial engineers, either in private practice or in staff work, for manufacture, merchandising, and service companies. The chapters naturally divide into four groups covering, respectively, the background, the motion-study phase, the time-study phase, and the application. Much of the text is devoted to one-man operations, but some space is given to multi-man operations. All of the illustrative material and case studies have been taken from investigations previously made in industrial and similar concerns.

The book follows the Gilbreth system of analysis and improvement which has been taught by Mrs. Gilbreth and others at Purdue University for probably a score of years, and also reinforced by a motion and time study laboratory for student research. The author, who is now chairman of the industrial engineering department at Purdue, gives credit to colleagues there, also to associates in other universities and in industry. The material and the method of presentation have been developed through use in colleges and in-plant training courses, at various levels, also for nonindustrial uses such as agriculture and home economics. The problem section, covering 32 pages, runs parallel to the text, and would be very valuable for both home study and round-table discussion.

H.H.F., W.S.E.

Book Browsings

Books Available at WSE Headquarters

Power Stability, Part One

Power System Stability, Volume 1: Elements of Stability Calculations, by Edward W. Kimbark. John Wiley & Sons, New York, 1948. 355 pages. $6.00.

While modestly subtitled "Elements of Stability Calculations," this book is unusual in that it offers a clear review of the underlying theory, explains the simplified methods of making the stability calculations, and also describes in detail the two types of alternating-current network analyzers which have proved to be almost indispensable in practical work on actual power systems.

The first six chapters of the book contain the descriptive text with some numerical examples and ample graphs and illustrations. There are also a number of problems which can be worked out by the reader if a thorough grasp of the fundamentals is desired.

In order to convey a clear conception of the methods and results obtained in the solution of stability problems by the previously described methods, the entire Chapter Seven is devoted to the description of four studies actually performed by a number of operating and engineering companies during the past few years. This condensed, yet complete, account of the work performed by practicing engineers on actual power systems should be of considerable interest to those who contemplate similar work. In this chapter there will be found not only the basic data of the power systems studied, but also the diagrams of system connections, the actual swing curves for various types and locations of faults, as well as the interpretation of the results and conclusions.

At the time of publication, Dr. Kimbark had been for several years professor of electrical engineering in the Technological Institute of Northwestern University. During his technical career, he has specialized in power-system problems, on which he has been the author of many papers and discussions.

A.J.K., A.I.E.E.

Practical Route Surveying

Route Surveys, by Russell R. Skelton, McGraw-Hill Book Co., Inc., New York, N.Y., 1949. 5531 Pages, $4.50.

Route surveying is that special phase of general surveying which applies particularly to the location of transportation and communication lines.

The purpose of this distinctive book is to bring together in one volume all the fundamental and practical considerations required by the engineer concerned with the various types of route locations. While written primarily for the student, it is nonetheless interesting to the average engineer who may not appreciate the intricacies of the design of a hillside curve or the economies and cost of highway right-of-way to by-pass a metropolis.

Emphasis is placed upon the importance of the engineering approach to the problems involved and the economic factors which influence route selection and surveys. The outstanding features of the book include: the application of aerial surveys; a new and unique approach to the treatment of simple circular curves by both arc and chord definition; and the inclusion in the chapter on spiral curves of a thorough treatment of the recently accepted highway spiral with the treatment of the well-known American Railway Engineering Association spiral.

Many well-chosen examples are included in the volume to illustrate methods, theory and economy and are amply supported by problems. Thirty-four tables of functions of curves, spirals, logarithms and formulae comprise half of the volume.

D.C.G., W.S.E.

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Helen Wierschem joined the staff of Engineering Societies Personnel Service, Inc., February 4, 1926, and has completed twenty-five years' service to the engineers in this area.

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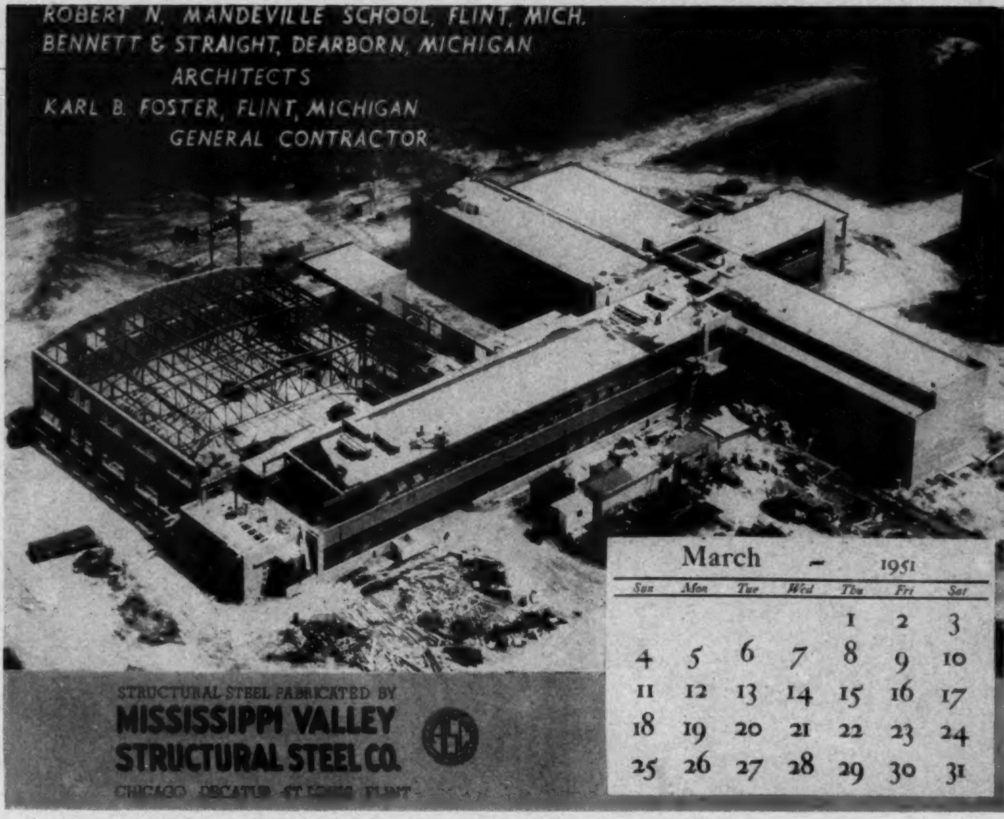

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When the Western Electric Company built their new plant northeast of Indianapolis, Ind., they installed the 500,000-gal. radial-cone tank shown at the left.

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